

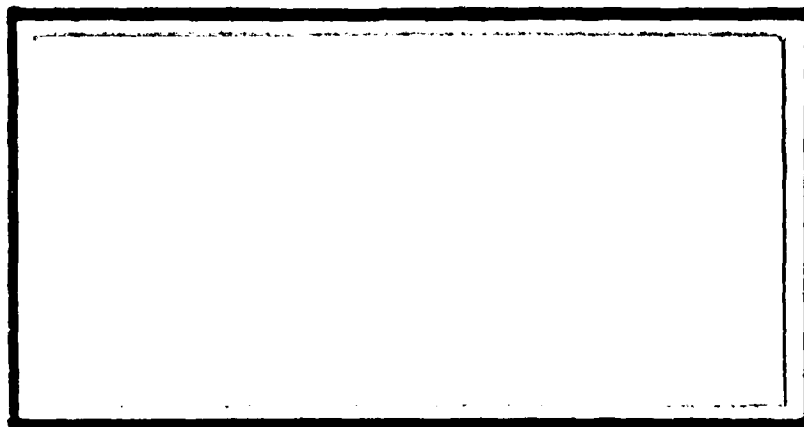
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**R & M 2000 MANAGEMENT:  
A TACTICAL AIR COMMAND PERSPECTIVE  
THESIS**

**James T. Silva, B.S.  
Captain, USAF**

**AFIT/GLM/LSM/88S-67**

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**AFIT/GLM/LSM/88S-67**

**R & M 2000 MANAGEMENT:  
A TACTICAL AIR COMMAND PERSPECTIVE  
THESIS**

**Presented to the Faculty of the School of Systems and Logistics  
of the Air Force Institute of Technology  
Air University  
In Partial Fulfillment of the  
Requirements for the Degree of  
Master of Science in Logistics Management**

**James T. Silva, B.S.  
Captain, USAF**

**September 1988**

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## Acknowledgements

An anonymous author once wrote,

Remember that there is nothing glamorous about maintaining aircraft and there never has been, but there are plenty of people who *like* aircraft maintenance. It is a source of self-satisfaction. It takes personal pride to work on a fine piece of machinery that demands the utmost in maintenance care. A lot of good maintenance men could still be in this profession if their efforts and accomplishments had been recognized.

Hence, this research is dedicated to those maintenance personnel in the Tactical Air Command, who taught me how to keep a positive attitude even under the most adverse conditions.

Additionally, my advisor, Major Bob Trempe deserves recognition for his ability to guide me toward the completion of this research effort. Without his probing questions, I would not have been able to develop the thought processes necessary to complete this thesis.

Special thanks also goes to Major Skip Collins from HQ TAC/SMO-R&M. His efforts in getting the necessary TAC backing and support for this project made the initial stages of this effort flow that much smoother.

Finally, and most importantly, I give my sincere appreciation and thanks to my wife, Sharlette, and my girls, Jennifer and Melissa. Without their support, and unlimited patience, this effort could not have been accomplished. Their encouragement leading to the completion of this thesis effort was immeasurable.

Jim Silva



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## Table of Contents

	Page
Acknowledgements .....	ii
List of Figures .....	vi
List of Tables .....	viii
Abstract .....	ix
I. Introduction .....	1-1
Overview .....	1-1
Background .....	1-2
Scope .....	1-4
Specific Problem Statement .....	1-5
Research Questions .....	1-8
II. Literature Review .....	2-1
Overview .....	2-1
Definitions of Reliability and Maintainability .....	2-1
History of Reliability and Maintainability .....	2-2
Development of the R & M 2000 Program .....	2-5
Tactical Air Command's Approach to R & M 2000 .....	2-9
Organizational Change .....	2-10
Institutionalization Defined .....	2-14

	Page
<b>III. Methodology</b> .....	3-1
Overview .....	3-1
Justification .....	3-1
Survey Population and Sample Description .....	3-2
Survey Questionnaire Characteristics .....	3-3
Data Collection and Statistical Analysis Plans .....	3-4
Unusual Aspects and Significant Hurdles of Methodology ....	3-6
<b>IV. Findings and Analysis</b> .....	4-1
Overview .....	4-1
Survey Structure Description .....	4-1
Survey Response Rates and Response Demographics .....	4-3
Survey Response Rates .....	4-3
Survey Demographics .....	4-5
Survey Response Biases .....	4-8
Recording of Findings and Statistical Tests .....	4-10
Program Implementation Survey Responses .....	4-11
Program Education and Training Survey Responses .....	4-52
Program Tools Identification Survey Responses .....	4-81
<b>V. Conclusions and Recommendations</b> .....	5-1
Overview .....	5-1
R & M 2000 Implementation in TAC .....	5-1
R & M 2000 Education and Training in TAC .....	5-4
R & M 2000 Tools Identification and Use in TAC .....	5-6
Overall Institutionalization of the R & M 2000 Program .....	5-8
Recommendations for Future Research .....	5-11
<b>Appendix A: Listing of Tactical Air Command Addresses</b> .....	A-1
<b>Appendix B: R &amp; M Management Survey Questionnaire</b> .....	B-1

	Page
Appendix C: Survey Median/Mode Response ..... Comparison Tables	C-1
Appendix D: Modal Frequency Histograms for ..... Survey Questions	D-1
Bibliography .....	BIB-1
Vita .....	V-1

## List of Figures

Figure	Page
1.1. R & M 2000 Principles and Building Blocks.....	1-3
1.2. A Typical TAC Wing Organizational Chart .....	1-7
2.1. R & M Audit Trails for Managers .....	2-7
2.2. Four Stages of Second Order Change .....	2-12
2.3. Dimensions of Second Order Change .....	2-14
3.1. Kruskal-Wallis H Test for Comparing Probability Distributions .....	3-7
4.1. Flow of Returning Surveys .....	4-4
4.2. Survey Response Scales (Section 1) .....	4-12
4.3. Section 1, Question 1 Survey Response Histograms .....	4-14
4.4. Section 1, Question 5 Survey Response Histograms .....	4-20
4.5. Section 1, Question 9 Survey Response Histograms .....	4-23
4.6. Section 1, Question 12 Survey Response Histograms .....	4-27
4.7. Section 1, Question 13 Survey Response Histograms .....	4-30
4.8. Section 1, Question 16 Survey Response Histograms .....	4-33
4.9. Section 1, Question 20 Survey Response Histograms .....	4-36
4.10. Section 1, Question 8 Survey Response Histograms .....	4-39
4.11. Section 1, Question 24 Survey Response Histograms .....	4-44

<b>Figure</b>	<b>Page</b>
4.12. Section 1, Question 28 Survey Response Histograms .....	4-52
4.13. Survey Response Scales (Section 2) .....	4-53
4.14. Section 2, Question 2 Survey Response Histograms .....	4-57
4.15. Section 2, Question 13 Survey Response Histograms .....	4-61
4.16. Section 2, Question 7 Survey Response Histograms .....	4-65
4.17. Section 2, Question 14 Survey Response Histograms .....	4-72
4.18. Section 2, Question 21 Survey Response Histograms .....	4-80
4.19. Survey Response Scales (Section 3) .....	4-82
4.20. Section 3, Question 3 Survey Response Histograms .....	4-86
4.21. Section 3, Question 22 Survey Response Histograms .....	4-90
4.22. Section 3, Question 28 Survey Response Histograms .....	4-97
4.23. Section 3, Question 16 Survey Response Histograms .....	4-101
4.24. Section 3, Question 12 Survey Response Histograms .....	4-106
4.25. Section 3, Question 20 Survey Response Histograms .....	4-115
4.26. Section 3, Question 27 Survey Response Histograms .....	4-118

### List of Tables

<b>Table</b>	<b>Page</b>
<b>4.1. Survey Response Rates by Manager Type .....</b>	<b>4-5</b>
<b>4.2. Maintenance Manager Average Time Demographics .....</b>	<b>4-7</b>
<b>4.3. Kruskal-Wallis H Test Results (Survey Section 1) .....</b>	<b>4-13</b>
<b>4.4. Kruskal-Wallis H Test Results (Survey Section 2) .....</b>	<b>4-55</b>
<b>4.5. Kruskal-Wallis H Test Results (Survey Section 3) .....</b>	<b>4-83</b>

Abstract

The R & M 2000 program, established to help reduce the burden of budget constraints on new and current weapon systems, provides a new outlook on the reliability and maintainability of all weapon systems. This thesis was based on the premise that to fully institutionalize the precepts of the R & M 2000 program, a change in the mindset of maintenance managers needs to occur. As such, a behaviorally oriented second order organizational change model was used to describe the stages of change managers progress through before any program becomes institutionalized.

Since its inception in 1985, no studies have been conducted addressing the level of institutionalization of the R & M 2000 program in the Tactical Air Command (TAC). In this study, the attitudes of 145 TAC Deputy Commanders for Maintenance and Squadron Maintenance Supervisors were surveyed to ascertain the extent of their institutionalization of the R & M 2000 program. To determine the level of institutionalization, questions were developed to measure the degree of program implementation, as well as the managers' level of R & M education and training. Additional questions assessed the level of use of specific R & M management tools.

Detailed analyses of the survey responses suggested that the implementation of the program was relatively low. The level of R & M education and training in TAC was also deemed as low. In evaluating the



tools used to manage the R & M program, the survey showed opposing results indicating high tool use. However, the maintenance managers were not commonly aware that the management tools they were using were actually the R & M 2000 tools. Statistical tests of the maintenance manager categories revealed that the survey response distributions could not generally be considered different, allowing conclusions to be applied across the entire spectrum of the maintenance manager population.

Contrary to expectations, this thesis concluded that the R & M 2000 program did not appear to be fully institutionalized into the Tactical Air Command environment. However, the institutionalization does appear to be beginning at the core process level. Any penetration of the R & M 2000 program to the paradigmatic level may take several more years.

# R & M 2000 MANAGEMENT: A TACTICAL AIR COMMAND PERSPECTIVE

## I. Introduction

### Overview

As a result of recent Department of Defense directives, reliability and maintainability terms have slipped into the documents of every new Air Force acquisition contract. However, these terms are not new to the Air Force. Reliability and maintainability concepts have been present in the military since the beginning of the United States (20:5).

Nevertheless, in today's Air Force, reliability and maintainability are difficult concepts to manage. This research was dedicated to evaluating how these concepts of reliability and maintainability are managed in a particular operational area of the Air Force.

This chapter will present a brief background of the Air Force's Reliability and Maintainability 2000 (R & M 2000) Program. The scope of this research effort will then be examined, followed by a statement of the specific problem at hand. Research questions will be identified. Subsequent chapters will elaborate on the background literature and describe the research methodology, analysis and conclusions. Lastly, recommendations will be posed for future research.

## Background

The acquisition process is a systematic procurement of resources, including goods and services, to meet determined requirements (24:151). In December of 1985, the Air Force initiated new policy with the R & M 2000 program for the inclusion of reliability and maintainability precepts into all new acquisition processes. The R & M 2000 program was developed by the Secretary of the Air Force and the Chief of Staff of the Air Force, indicating a high level interest in its success (8:1). According to Major General Jimmie Adams, the former Deputy Chief of Staff, Requirements, Headquarters Tactical Air Command (TAC), the "Air Force R & M 2000 Action Plan was developed to provide general policy and guidance to institutionalize R & M in the way we do business - now and in the future" (6:i).

The goals of the plan are described in detail by the current Air Force regulation AFR 800-18 (7:2). Briefly, the goals are to:

- a. Increase combat capability,
- b. Increase survivability of the combat support structure,\*
- c. Decrease mobility requirements per unit,
- d. Decrease manpower requirements per unit of output,
- e. Decrease costs.

\* Author's note: Reference USAF LE-RD message, 101300Z Jun 88, on 6 June 1988, the second goal of the R & M 2000 program was changed to read, "Decrease the vulnerability of the combat support structure." While recognizing the significance of this change, it was not issued in time to be incorporated into this thesis' R & M 2000 Management Survey. Responses were already received from the field when the change was issued. Nevertheless, the change was taken into consideration when the survey responses were analyzed and did not appear to affect the results of this thesis.

"These goals can be achieved by committed application of the R&M 2000 Building Blocks within the framework of the R&M 2000 Principles" (10:2). Below, Figure 1.1 shows the interrelationships of the Principles and Building Blocks of R & M 2000.

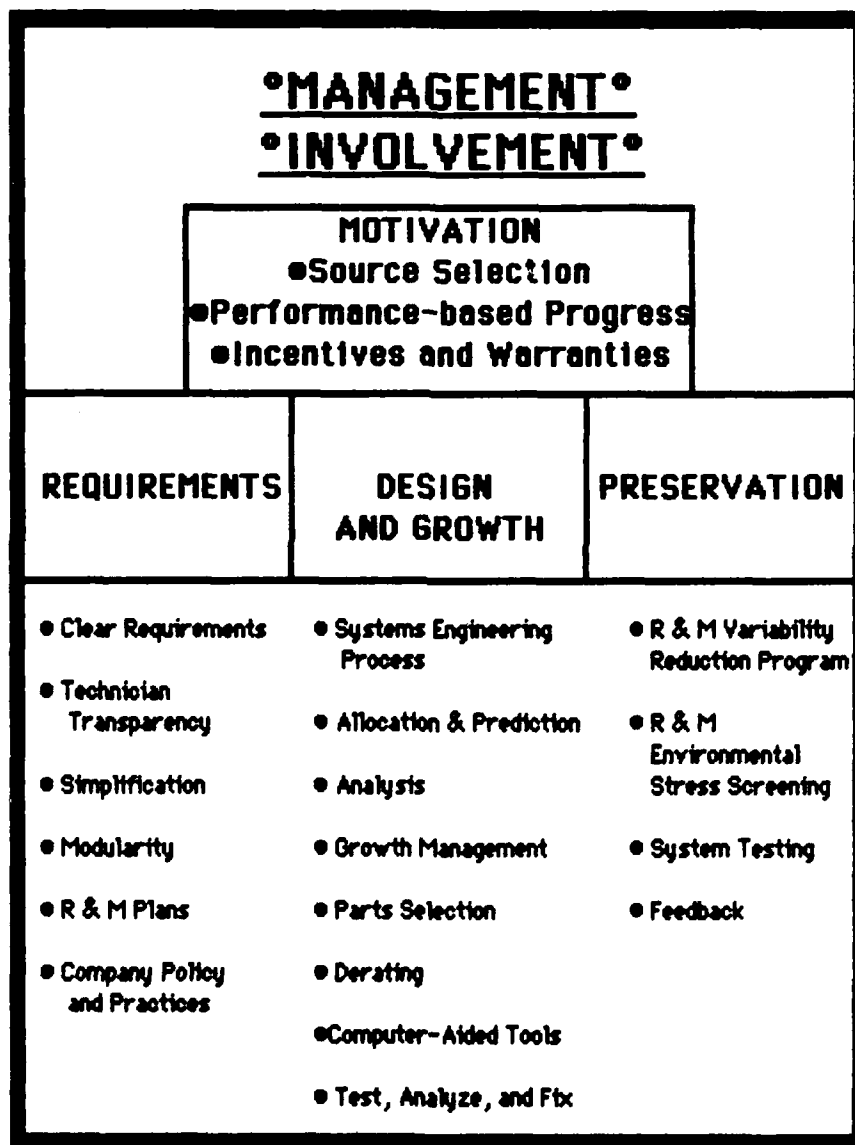


Figure 1.1. R & M 2000 Principles and Building Blocks (10:11)

The Building Blocks and Principles are "tenets and techniques which have been proven effective for designing, developing, and producing reliable, maintainable systems and equipment" (10:9). To meet the R & M 2000 goals, each major functional area in the Air Force was provided these general principles or guidelines to follow. These guidelines were very broad in nature. For more specific guidelines, "the building blocks (shown juxtaposed with the R&M 2000 Principles they directly support) are the best of what works *today*" (10:11). When used properly, the building blocks offer a high probability that the Air Force will meet the goals of the R & M 2000 program (10:11). Further details of the management and history of the Air Force's R & M 2000 program will be presented in the next chapter.

### Scope

As the Center of Excellence for Reliability and Maintainability, the Air Force Institute of Technology was tasked with studying management concerns dealing with the R & M 2000 program (7: 4.j.(5)). Research projects include the studies of R & M management concerns in the Air Force Systems Command and the Air Force Logistics Command. Other projects involve R & M education concerns in civilian industries or major corporations providing services or equipment to the Air Force. The primary emphases of these studies were to gain better understandings of how and to what extent managers have institutionalized the new R & M 2000 program into the acquisition process.

However, the acquisition process involves more than just the design process in AFSC and AFLC. It involves the 'using' commands: those that

actually use the Air Force weapon systems and equipment. The 'using' commands specifically input their new wants and desires for equipment improvements to the acquisition process via need or feasibility analyses (3:89). The primary emphasis in this research effort is to review the R & M institutionalization at the user or field level.

The Tactical Air Command has received many new weapon systems in the past fifteen years; the F-15, F-16, and A-10 aircraft are just a few examples. To keep those systems in top condition, managers must make critical decisions. Therefore, the management concerns of the managers in the Tactical Air Command are important in determining the overall institutionalization of the R & M 2000 program at the user or field level.

#### Specific Problem Statement

The preeminent R & M principle that guides the process and degree of institutionalization is management involvement. "Management involvement changes the work environment to institutionalize R & M" (10:13,14).

Institutionalizing R & M requires change. Management conviction and commitment to this change is absolutely necessary to convert the organization to take R & M seriously, meet users' needs, do things right the first time, and instill in the organization a clear sense of performance standards [10:13].

In the development of the R & M 2000 program, no specific performance standards were delineated stating whether field level managers must continue doing their jobs as always, or whether they were to accomplish and report something new. Without specific guidelines, how could the extent of institutionalization of the R & M 2000 program in any TAC managers be measured?

To date, no specific management studies addressing the R & M 2000 program institutionalization have been conducted in the Tactical Air Command. Inasmuch as no previous studies were available, the concept of institutionalization had to be explicitly defined in order to be able to measure levels of TAC manager involvement. In this research, institutionalization was assessed by determining how managers implemented the program, ascertaining how the managers were educated, and seeing what tools they used to manage the program. Ultimately, questions of the degree which TAC managers are absorbing the new policy directives of the R & M 2000 program should be answered in order to draw conclusions concerning the institutionalization of the overall program.

Targeted TAC Managers. The managers targeted for this study were TAC's maintenance managers. Maintenance managers were defined as those directly contributing to the maintenance effort on a daily basis. More specifically, the maintenance managers studied were the TAC Deputy Commanders for Maintenance (DCMs) and their subordinate Squadron Maintenance Supervisors. On the following page, Figure 1.2 shows an organizational chart extracted from TAC Regulation 66-5 to show the relationships of the DCMs and the Maintenance Supervisors in their normal chain of command (9:1-6, 1-7).

The Deputy Commanders for Maintenance and their Maintenance Supervisors possess the direct responsibilities for maintenance production and operations (9:2-3, 2-11, 2-12). One of the general assumptions of this entire research is that once the ideas of the R & M 2000 program are institutionalized in those managers, the program should become 'a way of life' for the typical TAC maintenance organization.

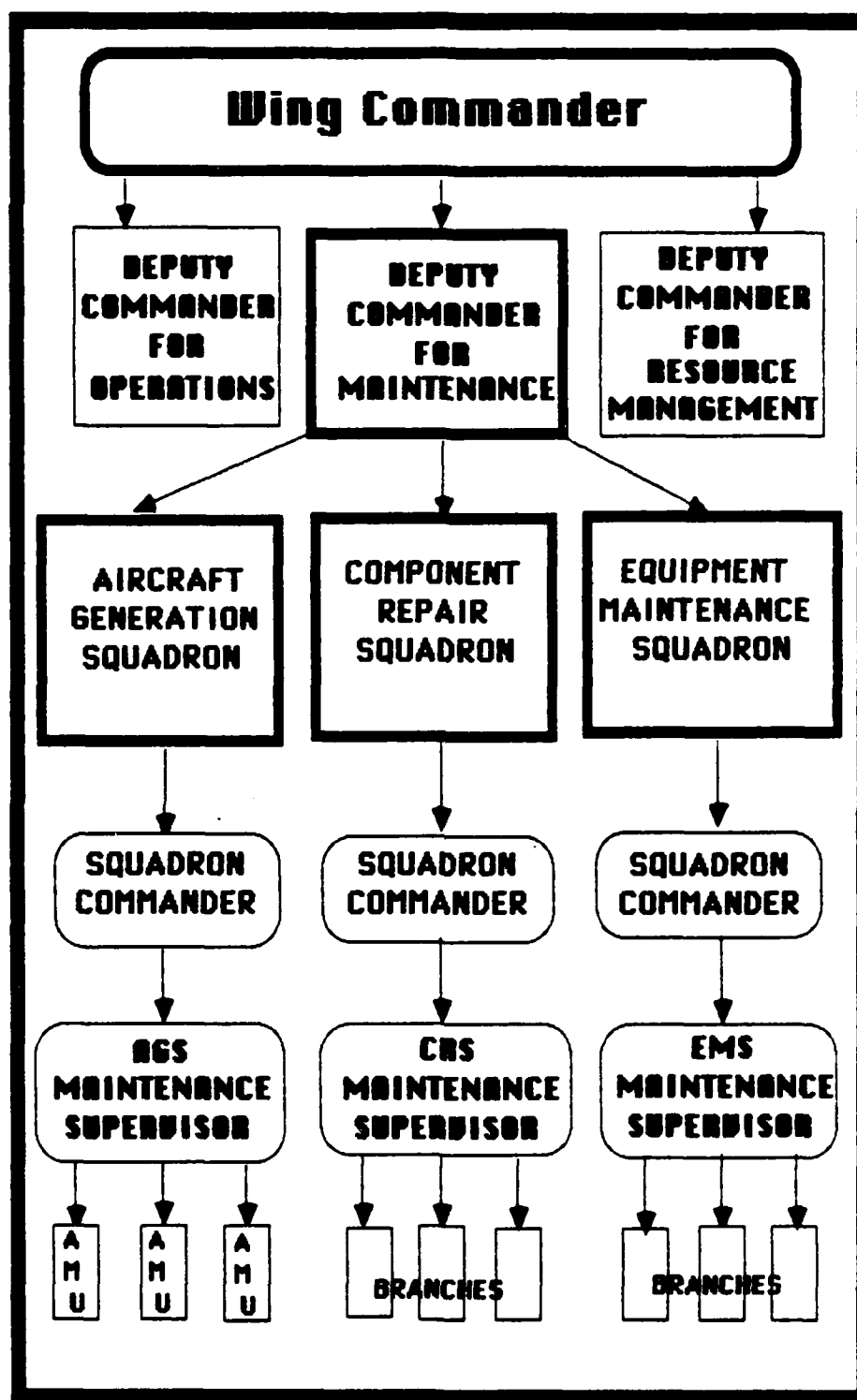


Figure 1.2. A Typical TAC Wing Organizational Chart (9:1-6,1-7)



### Research Questions

The following investigative questions were posed to facilitate determining the details and trends of institutionalization of the R & M 2000 program in TAC maintenance managers.

A. How is the R & M 2000 program being implemented in TAC maintenance organizations? How are the maintenance managers planning, organizing, and controlling the new program? How does this affect the institutionalization of the program?

B. How much R & M 2000 education and training have the TAC maintenance manager's received? How does this education aspect affect the institutionalization of the program?

C. What tools are in use for measuring the R & M 2000 program goals in TAC maintenance organizations? Does the use of those tools enhance the institutionalization process?

## II. Literature Review

### Overview

This chapter will provide the background literature review of this R & M management study. First, the definitions and history of reliability and maintainability will be outlined. The development of the Air Force R & M 2000 program will follow. Then, a description of Tactical Air Command's approach to Reliability and Maintainability is essential. This allows a comparison of the Headquarters view of the program to see if it may have any influence on the DCMs and Maintenance Supervisors institutionalization of the program. Finally, a review of organizational behavior is in order to justify the definition of institutionalization and the process by which it is being measured in the survey questionnaires.

### Definitions of Reliability and Maintainability

Logistics is usually described in terms of a system. The system involves planning, analysis and design, testing, production, distribution, and sustaining support throughout the life cycle of that system (3:5). These factors are all programmed together in an effective and economical way for that system to be of any use (3:22). According to Blanchard, all logistical system requirements should be specified in qualitative and quantitative terms (3:22). Qualitative attributes of logistics are based on judgment and common sense. Quantitative factors are the system's required configuration and specifications.

Reliability and maintainability are two such quantitative factors in the logistics environment. Reliability is defined simply as the probability that a system or product will perform in a satisfactory manner for a given period of time when used under specified operating conditions" (3:12). Frequency of maintenance is a significant parameter when measuring the capabilities of a system. Reliability is inversely proportional to the frequency of maintenance: "as the reliability of a system increases, the frequency of maintenance will decrease" (3:23). Measures of reliability commonly include the failure rate, operating time, and Mean Time Between Failure (MTBF) (3:28, 18:39-40).

"Maintainability, like reliability, is an inherent characteristic of system or product design" (3:15). Maintainability actually refers to the ease, accuracy, safety, and economy in the performance of any maintenance actions (3:32). Measures of maintainability commonly include personnel labor-hour rates, elapsed times, maintenance frequencies (mean-time-between-maintenance and mean-time-between-replacement), and maintenance costs (3:32).

### History of Reliability and Maintainability

"Maintenance, as we know it today, did not exist in 1776. There were not any established procedures for maintaining such things as weapons or wagons" (20:22). It wasn't until World War I that maintenance became part of the logistics process (20:22). What generated the change in maintenance awareness were technological increases in weaponry which ultimately demanded more supplies and spare parts to effectively continue operating.

With continuing technological improvements in the military weaponry field, the awareness of maintenance continued to grow.

Finally, "in September 1956, a new era in aircraft maintenance was launched with the publication of Air Force Manual (AFM) 66-1, *Maintenance Management Policy*" (20:150). This new policy gave specific guidance involving the concepts of reliability and maintainability (20:151). As more and more people became aware of R & M, more and more policies began to evolve. In the late 1960s, the Air Force Logistics Command built a management information system designed to access data generated from maintenance reports (20:175). As a result, management could "focus attention on correcting the reliability of systems or subsystems that were preventing weapon systems from accomplishing their missions" (20:175).

Dovetailing closely with R & M was the concept of Reliability Centered Maintenance (RCM). RCM refers to "a scheduled-maintenance program designed to realize the inherent reliability capabilities of equipment" (18:2). Commercial airlines in the United States had been using RCM prior to the mid-1970s when the Department of Defense became interested in the concept. "The Department of Defense interest in RCM stemmed from the need to improve materiel readiness and monetary savings in the aircraft maintenance area" (20:182).

The basis for RCM decision logic focuses on three significant questions (18:6):

- a. How does a failure occur?
- b. What are its consequences?
- c. What good can preventive maintenance do?

To monitor these significant areas, RCM programs set up four basic maintenance tasks: (1) scheduled inspections of items at regular intervals to find any potential failures, (2) scheduled rework of items at or before some specified age limit, (3) scheduled discard of items at or before some specified life limit, and (4) scheduled inspection of hidden-function items to find any functional failures (18:50). The first three tasks were aimed at preventing single item failures, whereas the fourth was aimed at preventing multiple item failures. These guidelines from the civilian based RCM programs were not totally incorporated in the Department of Defense RCM program. As the RCM program began to grow in the Air Force, problems arose.

An Air Force Inspector General Functional Management Inspection in 1978-79 contained several findings. First, no explicit guidelines had ever been given by the Secretary of Defense in defining the purpose of the RCM program. No stated objectives, no expected benefits, nor an assessment of the benefits of RCM had been issued by the Defense Department. Second, the analysis of the RCM concept had not been consistent among the various weapon systems in the Air Force. ... Of primary concern to the services was the absence of a definition and principles outlining the objectives of RCM [20:183].

Despite the apparent problems with RCM, the Air Force continued to use the program's concepts. The Air Force, as well as the civilian world, had gradually recognized that safety and reliability were no longer synonymous in the case of aircraft (18:370). Aircraft and equipment no longer had to be designed with only safety in mind; aircraft could now be designed and effectively maintained with reliable components. The specific guidelines of reliability and maintainability would eventually be presented in a documented format.

## Development of the R & M 2000 Program

Department of Defense Directive. In July 1980, the Department of Defense published a directive concerning the subject of Reliability and Maintainability. The purpose of the directive was to establish policies and responsibilities for R & M. Policy was finally documented that included a set of objectives for defense R & M activities. They included (5:1):

- a. Operational Effectiveness. Increase operational readiness and mission success of fielded items.
- b. Ownership Cost Reduction. Reduce demand for maintenance and logistic support of attached and detached item components.
- c. Limit Manpower Needs. Field items that can be operated and maintained with skills and training expected to be available in the Department of Defense.
- d. Management Information. Provide specific types of R & M data essential to acquisition, operation, and support management.
- e. Efficiency. Ensure that each increment of cost and schedule investment in R & M contributes significantly to the above objectives.

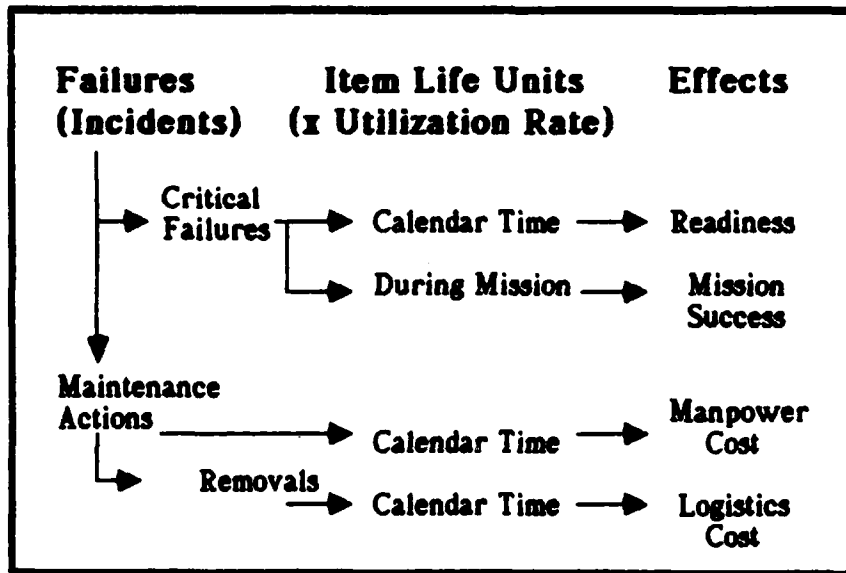
Following these objectives, each DoD component had the ability to set up their own R & M program. Each program had to include a "balanced mix of R & M engineering and accounting tasks" (5:2). R & M engineering focused on the prevention, detection and correction of deficiencies, whereas R & M accounting focused on providing accurate data to the acquisition, operations, and support management processes (5:2). Most of the

accounting information came from data created when the weapon system or equipment item was being tested prior to fielding (5:2-6). The DoD directive does include some general guidelines concerning the 'using' command's responsibilities in the R & M process. Where the guidelines primarily centered around responding to and reporting failures, they also addressed weapon system improvements in the R & M process (5:6). The directive also included a set of reliability and maintainability audit trails for R & M managers to follow. Figure 2.1 on the following page shows where the ultimate effects of R & M actions fall with respect to the overall R & M program objectives.

Air Force R & M 2000 Program and Policy Letters. In 1985, the Air Force set its own policies involving R & M. It emphasized that "reliability and maintainability must be co-equal with cost, schedule and performance factors as the Air Force brings new systems into the inventory and modifies its existing systems" (8:1). This Air Force R & M 2000 program policy detailed a slightly different set of objectives and took one step further in defining specific measureable and quantifiable R & M goals. The goals were those previously listed in Chapter I.

The Vice Chief of Staff, Headquarters USAF, issued additional policy letters concerning R & M 2000. Each of the policy letters, issued between January 1986 and June 1987, set even more specific guidance concerning overall Air Force directives (8:Policy Letters 1-5). The first policy letter outlined specific Environmental Stress Screening requirements to be accomplished in the factory before failures reached the field. The second policy letter specifically addressed the subpolicy of "Double-R/Half-M,"

## RELIABILITY AUDIT TRAILS



## MAINTAINABILITY AUDIT TRAILS

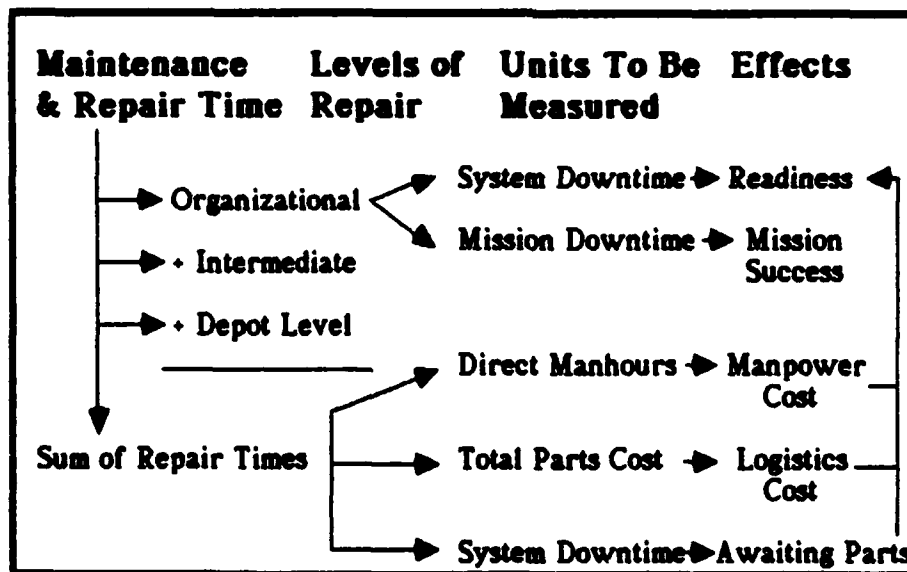


Figure 2.1. R & M Audit Trails for Managers (5:A-3)  
(Necessary for Managers to Determine Effects of R & M Actions)



where new acquisition documents were all required to insist on double the reliability of current systems while incurring half of the maintenance requirements. The third policy letter discussed "a key program under the R & M 2000 umbrella, the Blue Two Visit program ... [which] takes lead design engineers from defense contractors to the various locations where their equipment or similar systems are in use on Air Force flight lines" (8:4). The visits were intended to show the engineers what the maintenance world was really like. The fourth policy letter remphasized the Air Force's commitment to reliability by establishing guidelines requiring all avionics line replaceable units (LRUs) to achieve a minimum of 2000 hours of reliability (2000 hours MTBF). The final policy letter required all civilian employees in positions involving R & M 2000 be rated on R & M in their performance plans. This would provide incentive to the civilian employees to concentrate more on R & M concepts.

Air Force R & M 2000 Program Regulation. In October of 1986, the Air Force incorporated the Department of Defense Directive 5000.40 and the R & M 2000 program Policy Letters into a regulation, AFR 800-18 (7:1). This regulation described the R & M 2000 program in even more detail. The 'using' commands were finally referenced in the descriptions of the responsibilities of the Major Commands (MAJCOMs) (7:para 4c). However, these responsibilities were very broad in scope. Basically, they required the MAJCOMs to designate a separate Office of Primary Responsibility (OPR) and to develop a command plan. This command plan was intended to define any specific command goals, detail processes to measure R & M data, and address any R & M issues and problem areas. Additionally, they

required the development and implementation of inspection criteria to ensure command R & M policies were followed. Training was also addressed for the MAJCOMs.

The regulation ultimately left the overall quantification of the goals to the 'using' commands (7:A1-3). No specifics were listed other than the requirements generated by the original five policy letters from the Vice Chief of Staff.

#### Tactical Air Command's Approach to R & M 2000

As required by AFR 800-18, the Tactical Air Command developed an "Action Officers Guide for Reliability and Maintainability." The purpose of the guide was "to help action officers responsible for managing acquisition or major modification programs to better understand the interrelationships between R & M performance and operational capability" (6:2). The guide went into great detail describing the costs involved with R & M and how the action officer must take all of the intervening R & M factors into consideration when developing TAC Statements of Need (SONs) (6:3-13). The remainder of the Action Officers Guide was designed to familiarize the action officer with methodologies to incorporate R & M into the SON. It listed several formulas that could "provide assistance in developing and integrating R & M parameters required in acquisition documents" (6:14-17). Overall, the Department of Defense Directive, the Air Force Regulation, and the TAC Action Officers Guide did not give any specific guidelines to assist the managers *in the field* in determining their responsibilities.

## Organizational Change

Since none of the R & M 2000 program guidelines provided specifics for the field managers, it is difficult to determine if those managers have actually institutionalized the program concepts. In order to evaluate the degree to which managers have institutionalized the R & M 2000 program, a definition of institutionalization must first be formulated. Initially, organizational behavior studies were reviewed to see if there was any previous research conducted to measure the institutionalization process. Organizational change was examined before an institutionalization definition was developed.

Planned Change. "Organizations exist in an environment of change" (19:183). Planned change involves "a deliberate, purposeful, and explicit decision to engage in a program of change" (16:6). In general terms, planned change is described by (19:183, 15:50, 95-100):

- a. Unfreezing -- creating the awareness of the need to change,
- b. Changing -- actually initiating the change, and
- c. Refreezing -- stabilizing the change by sustaining the new state.

Managers commonly provide the impetus to change. The change in the case of R & M 2000 was generated by higher level management.

*Planned change* usually refers to the way in which internal and external experts can help the organization cope with difficulties and plan and implement changes. *Managed change* usually refers to the way in which managers can plan and implement changes [16:6].

Second Order Change. "While the idea and definition of planned change are well researched and agreed upon, the definition of *second-order change* has not yet been thoroughly researched and defined in specific terms"

(16:7). Second order change is defined as a change that "has occurred in the very essence, in the core" (21:318). Gerlach and Hines further defined a second order type of change as a revolutionary change: one "that replaces existing goals with an entirely different set of goals steering the system in a very different direction" (12:8). The R & M 2000 program can thus be viewed as a case of second order change because of the change in goal orientation from designing to optimize costs to designing to optimize reliability and maintainability.

To better understand second order change, Levy posed three questions: (1) why do organizations change?, (2) how do organizations change?, and (3) what is actually changed? (16:10). In analyzing the answers to each of these specific questions, the overall reasons for second order change become clear. The 'why' of any change involving a new program is simple to resolve. Higher level management states there will be a change and then regulations are written to back up the management's decision. "In 80% of the case studies, the change was triggered by a new manager" (16:13).

'How' a change is developed entails a much deeper analysis. On the following page, Figure 2.2 displays Levy's four stages in a cycle of second order change (16:13-15). In evaluating the institutionalization of the R & M 2000 program, the fourth stage of 'stabilization and development' must be looked at. This stage is where the "change program is institutionalized, tuned up, maintained, and developed by first-order changes" (16:14). Very few studies have been conducted in determining how institutionalization occurs (22).

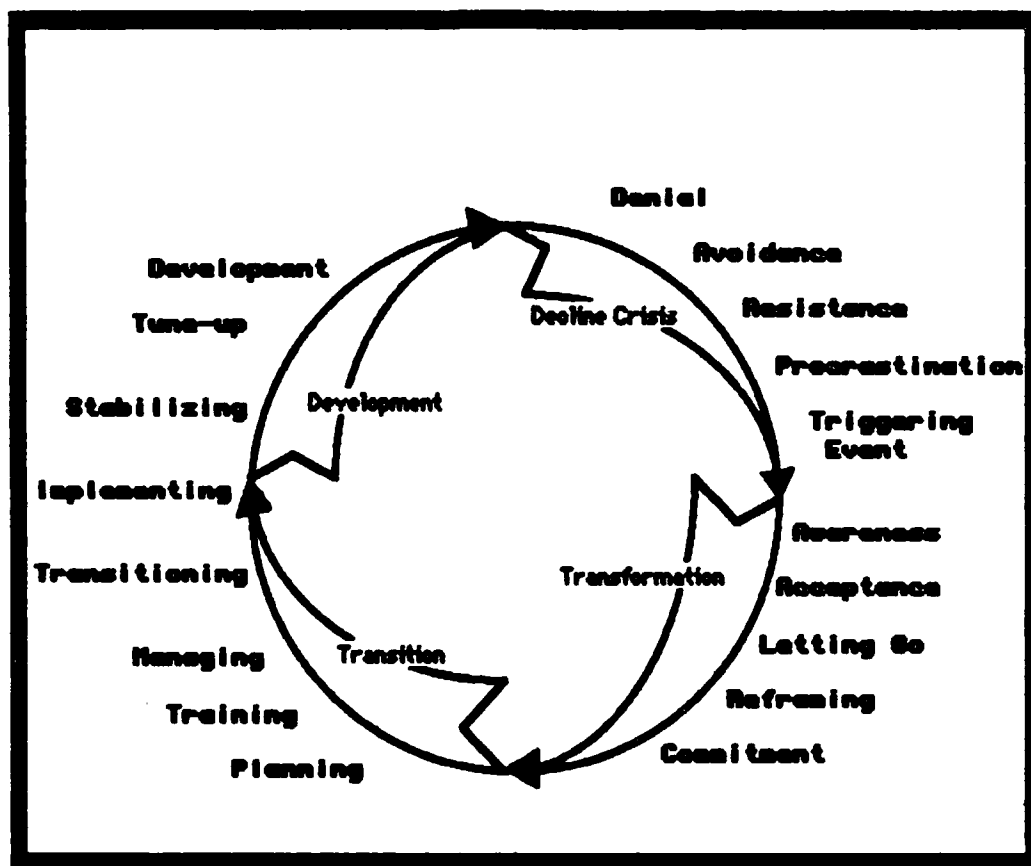


Figure 2.2. Four Stages of Second Order Change (16:14)

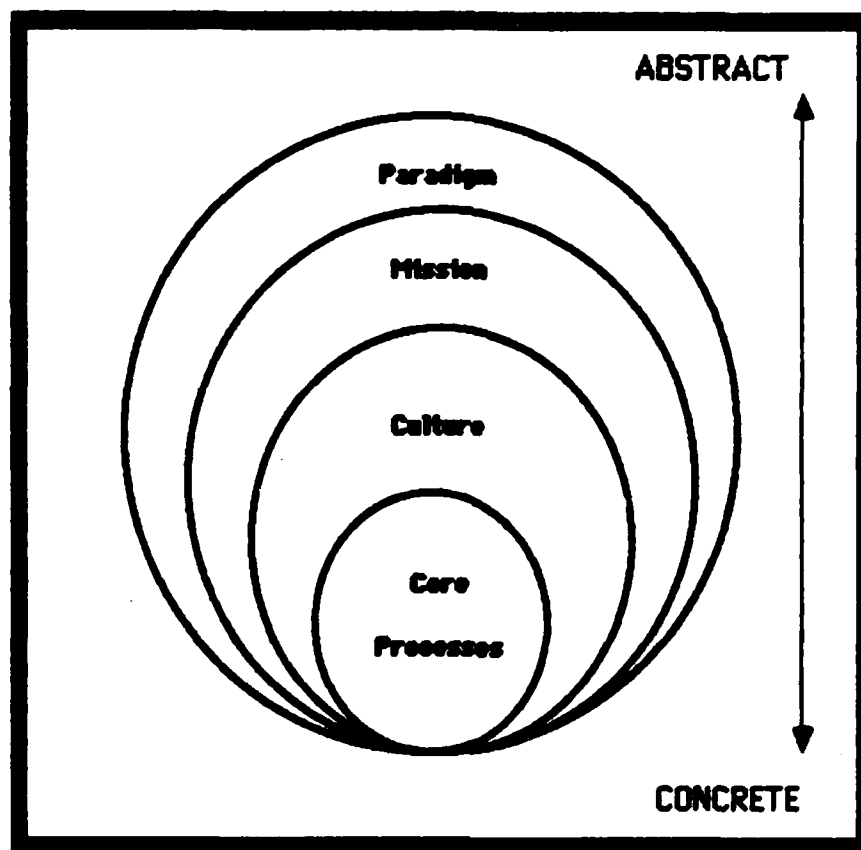
In contrast to institutionalization, internalization has been studied extensively. However, internalization is a term that is used commonly to refer to how individuals change (14:290). "[I]nternalization is a more common outcome in those influence settings where the direction of change is left more to the individual" (14:290). Supporting this difference in definitions between institutionalization and internalization is Robbins' account of attribution theory indicating "internally caused behaviors are those that are believed to be under the personal control of the individual"

(19:19). Therefore, even though the concepts are related, internalization cannot be used directly to define 'how' a change might be institutionalized.

Finally, Levy's third question of 'what' is changed must be addressed. Different changes affect different elements and dimensions of an organization (16:15). As shown in Figure 2.3 on the following page, the dimensions of change range from the paradigmatic level to the level of core processes (16:16). The definitions that follow for each of the dimensions are easy to understand, but care must be taken when trying to place an idea in just one dimension; they often overlap because of the embedded circles within each dimension (16:17).

- a. Paradigm -- the 'whole picture' or "underlying assumptions than unnoticeably shape perceptions, procedures, and behaviors",
- b. Mission -- the more explicitly stated programs for direction of action,
- c. Culture -- the organizational beliefs, values, and norms, and
- d. Core Processes -- the organizational structure, management, and decision making patterns.

The level of change for the R & M 2000 program is difficult to determine. The intent of the regulations, policy letters, and generally high level of management interest indicate the change is directed at the higher paradigmatic level. In this particular case, the changes in the regulation and guidelines are indeed abstract in nature. Any R & M 2000 program mission, culture, and core process changes should be "nested" in the paradigmatic change (16:17).



**Figure 2.3. Dimensions of Second Order Change (16:16)**

### **Institutionalization Defined**

As a result of the above review, the term institutionalization remained undefined in terms of prior research. An operational definition of institutionalization was, therefore, developed based on several different previously noted aspects of change and R & M concepts.

The "USAF R & M 2000 Process" pamphlet, issued in October of 1987, indicates "management involvement changes the work environment to institutionalize R & M" (10:14). As such, the definition of institutionalization directly involves the managers themselves. First, details of how the

**R & M 2000 program is being implemented should be determined.**

**According to Bennis, "what we know least about -- and what continually vexes those of us who are vitally concerned with the effective utilization of knowledge --is implementation" (2:175). In this research effort, implementation includes specifics about how the managers are planning, organizing, and controlling the program. The change that this will measure in Levy's model is the 'Mission' dimension. Second, it should be determined how much education and training the managers have received. This should show the managers are bonding together "to move the system toward new ways of doing, thinking, and learning" (1:26). Education and training will quantify the 'Culture' dimension. Finally, it should be determined what tools for measuring the R & M 2000 program goals are in use. The tools add value to the 'Core Processes' dimension. Since "each level is embedded in and shaped by higher levels," the cumulative results should show characteristics of institutionalization at the 'Paradigm' dimension (16:17).**



### III. Methodology

#### Overview

This chapter provides the methodology used to collect data for this research study. First, justification for using the survey approach to gather data is discussed. Second, the survey population and sample are described. Then, details of the survey questionnaire, and the statistical analysis plan are enumerated. Finally, unusual aspects and significant hurdles of this research study methodology are presented.

#### Justification

The specific data collection method chosen for this research was the survey. Since no previous TAC management studies were available to review, new data needed to be collected from the field. In total, the survey was designed to extract information from the respondents about the actual management processes they used in institutionalizing the R & M 2000 program precepts. Survey questions were specifically developed to gather data based upon the three significant areas of investigation:

- (1) program management or implementation,
- (2) program education and training, and
- (3) program tools identification.

### Survey Population and Sample Description

The population for this research study included a wide variety of TAC maintenance managers. The level of managers ranged from the Deputy Commander for Maintenance to the lowest level manager in any Aircraft Maintenance Unit or Branch. The population is not limited not officers; managers in the enlisted corps are also included in the population.

Two specific subpopulations of maintenance managers were extracted from the population for this research study's survey: the TAC Deputy Commanders for Maintenance and the Squadron Maintenance Supervisors. As previously stated, they bear the primary responsibilities for the decisions involving maintenance production and operations on the flightline. A census of these subpopulations of managers was conducted as follows:

(1) All Deputy Commanders for Maintenance (DCMs) listed in the TAC Monthly Maintenance Summary were surveyed. A total of 39 DCMs were listed. Appendix A shows an extract of the TAC Monthly Maintenance Summary for March 1988 with all applicable DCMs and their respective addresses.

(2) In virtually all cases, three Maintenance Supervisors were assigned under each DCM. They corresponded to the Aircraft Generation Squadron (AGS), Component Repair Squadron (CRS), and Equipment Maintenance Squadron (EMS). In a few cases, particularly in Consolidated Aircraft Maintenance Squadrons (CAMS), only one or two Maintenance Supervisors or Branch Officers in Charge were assigned. Despite possible squadron size differences, all Maintenance Supervisors were surveyed. A total of 106 managers fit into this category.

- (3) The total sample surveyed included 145 maintenance managers.
- (4) The same survey questionnaire was used for both ECMs and Maintenance Supervisors.

### Survey Questionnaire Characteristics

Unidimensional preference questions, measuring only one attribute or preference of the respondent at a time, were used in the survey questionnaire (11:243). All questions were formatted on a Likert scale (4:39). Limited response categories for the respondents' preferences ranged from values of one to seven (13:177). Scale headings for certain questions varied slightly. This variation was based on the type of information those particular questions solicited. The survey questionnaire is included in Appendix B.

Pretests of the survey instrument were conducted primarily on Air Force Institute of Technology (AFIT) School of Systems and Logistics students with maintenance backgrounds. These pretests were aimed at validating the respondents time to accomplish the survey. Additionally, pretests were administered to AFIT instructors with R & M backgrounds to confirm the relevancy of the survey questions. Overall, these pretests paid particular attention to:

- (1) Bias,
- (2) Question relevancy and information usefulness, and
- (3) Question clarity/meaning.

### Data Collection and Statistical Analysis Plans

Information was collected from each respondent with respect to their grade, position and time in that position, time in maintenance, weapon system, and base location. This allowed responses to survey questions to be compared based on those different demographic features.

The type of statistics chosen to compare survey responses was based on the type of data gathered. Opinion and preference scale data are normally considered to be on ordinal scales (11:89). As a result, nonparametric statistics were used to analyze the survey responses (13:166). Survey responses were tabulated on a Microsoft Excel spreadsheet program on a Apple Macintosh personal computer. Findings were generalized with regard to DCMs and Maintenance Supervisor types. Statistical correlations were then conducted to determine possible relationships between all variables. Base location and aircraft weapon system type were not considered adequate correlation bases. Any generated statistics would not show any further insight as to the extent of institutionalization of the R & M 2000 program in TAC maintenance managers.

Central tendencies and dispersions of the survey responses were expressed in terms of medians and modes. Histograms were developed for the modal responses per four maintenance manager categories: DCMs, AGS Maintenance Supervisors, CRS Maintenance Supervisors, and EMS Maintenance Supervisors. Branch Officer's in Charge were placed in the category of maintenance manager most similar to the duties they accomplished. It is also important to note that assistants for each of the categories were allowed to respond in place of the primary manager. This

addition of assistants encouraged some responses that otherwise may not have been received. The demographic analysis in the following chapter shows the breakout of maintenance manager information. Furthermore, Appendix A, primarily showing the list of addressees for the survey, shows the applicable categories for all respondents.

Median and modal values for each survey question were calculated and are tabulated in Appendix C. For further comparison and analysis of the median versus the modal values, modal histograms were created. Appendix D contains charts for all 77 survey questions. An analysis was then conducted to determine if any of the medians or modes in any of the four maintenance manager categories varied by more than two scale points. If no variations were noted, findings were based on the shapes of the modal frequency charts and the median/mode response comparison table.

If variations of more than two scale points were noted in comparing the medians or modes between maintenance manager categories, the non-parametric Kruskal-Wallis  $H$  Test for a completely randomized design was used as the statistical basis to determine the likelihood that the populations were the same or different (17:778). "The Kruskal-Wallis Test requires no assumptions concerning the population probability distributions to compare the  $k$  populations" (17:754). As such, no assumptions of normal probability distributions with equal population variances needed to be made. To accomplish the  $H$  test, rank sums were computed for each survey response according to the relative magnitude of the measurements. Null and alternative hypotheses were established for each applicable question. Finally, the test evaluated whether or not the populations had

identical probability distributions (17:754). The Figure 3.1 on the following page shows the generic statistical test accomplished for each survey question.

A detailed analysis of the medians and modes of the survey questions and significant findings from the results of all statistical tests will be discussed in the following chapter. A final analysis summarizing all of the statistical relationships should show the level that TAC maintenance managers have institutionalized the concepts of R & M 2000.

#### Unusual Aspects and Significant Hurdles of Methodology

As portrayed in Figure 1.2, the normal Wing organizational chart, Squadron Commanders fall in the next level below the DCMs (9:1-6). These Commanders were bypassed in this research survey effort. Justification for this was based on the fact that the day-to-day production and operations of the flightline are not usually conducted by these Commanders. They normally delegate that maintenance responsibility to the Maintenance Supervisors.

A second unusual hurdle in this research effort's methodology was a recommended constraint set by Tactical Air Command Headquarters. Their input was to not include a choice for "no extent" in the survey instrument response scales. Their justification for this was that the R & M 2000 program was directed by higher levels of command and there should be *no manager* with the attitude that the program has not been institutionalized to any extent at all. This recommendation did not pose a significant problem for this research. Any conclusions made to the very little extent

**H<sub>0</sub>:** The 4 probability distributions are identical.

**H<sub>a</sub>:** At least 2 of the 4 probability distributions differ in location.

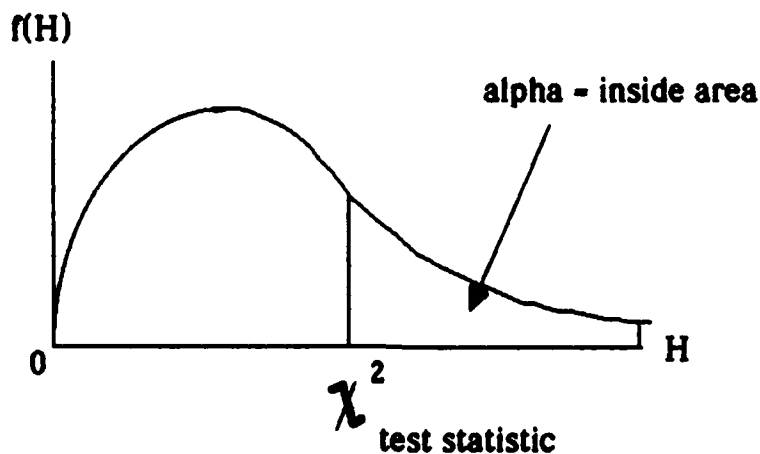
**Test Statistic:**  $H = \left[ \frac{12}{n(n+1)} \sum_{j=1}^4 \frac{R_j^2}{n_j} \right] - 3(n+1)$

$n_j$  - number of measurements in sample  $j$

$R$  - rank sum for sample  $j$ , where the rank of of each measurement is computed according to its relative magnitude in the totality of of data for the 4 samples.

$n$  - total sample size

**Rejection Region:**  $H > \chi^2$  with 3 degrees of freedom



**Figure 3.1. Kruskal-Wallis H Test  
for Comparing Probability Distributions (17:756,757)**

should just be tempered with the fact that these might include some "no extent" values that just went on record as "very little extent" responses.

As previously stated, only TAC maintenance managers were being surveyed to limit the scope and size of the research. Further research may analyze similar correlations with other commands.

Finally, as with many single iteration surveys, the non-response by survey respondents was expected to be near 50%. However, as long as the attrition was random, obtained results may still be significant. The randomness of the survey returns is discussed in the following chapter.



## **IV. Findings and Analysis**

### **Overview**

The basis of this chapter is the findings and analysis of the survey instrument used to gather institutionalization information from Tactical Air Command's maintenance managers. The structure of the survey is detailed first, followed by an analysis of survey response rates and demographics. Survey response bias is then discussed. Finally, this chapter concludes with the lengthy recording of the survey findings and the statistical tests used to validate those findings. Overall, findings were discussed by survey section.

### **Survey Structure Description**

The survey instrument used for this research endeavor was developed by the researcher. After pretesting, the instrument was approved by the Survey Control Office located at the Manpower Personnel Center at Randolph AFB, Texas. A sponsorship cover letter accompanied the survey instrument when it was mailed to the field. The letter was issued by the Headquarters Tactical Air Command Director of Maintenance Engineering and was intended to encourage maximum response by the Tactical Air Command Deputy Commanders for Maintenance and Squadron Maintenance Supervisors.

The structure of the survey was designed to elicit opinions from the respondents to allow a viable analysis of the extent of R & M 2000 institutionalization in TAC managers to be conducted. The survey, included

in Appendix B, was divided into four sections. The first section was a list of demographics. Analysis of the information returned by the respondents allowed a comparison of the types of experience and background the managers actually had in the Tactical Air Command. Also included in the demographics was the critical question of whether or not the respondent had been formally trained on the concepts of R & M 2000. The results of the analysis will be discussed in following sections of this chapter.

The second section of the instrument was actually titled Section 1. This section was designed to extract opinions and attitudes of the maintenance managers concerning the first research question, that being how the R & M 2000 program is being implemented. Twenty eight questions were asked using two types of scales. The first 19 questions ranged on a scale of 1 (to a very little extent) to 7 (to a very great extent). The remaining nine questions ranged on a scale of 1 (strongly disagree) to 7 (strongly agree). Several questions were worded in such a fashion so as to preclude inaccurate responses; the desired responses were reversed to insure the questions were being read and understood.

The third section of the survey, was designed to draw responses concerning the second research question regarding the training and education of the maintenance managers. Again the scale was varied to match the scale headings to the type of response of the questions. In this section the scale of 1 (strongly disagree) to 7 (strongly agree) was used for Section 2's first 16 questions. The remaining six questions used the same extent scale as used in Section 1. In this section, several questions were designed simply to detect recognition of common R & M 2000 terminology.

Finally, the last section of the survey, entitled Section 3, was designed to answer the third research question of the extent the maintenance managers use the tools of R & M 2000 in their organizations. The first 14 questions used the extent scale. The next seven questions used the agree/disagree scale. The last seven questions ranged on a new scale of 1 (all of the time) to 7 (never). It was important to note that this last set of questions were also arranged in such a way to again ensure accurate responses. In this case, the scale was reversed with the strongest positive value being the low value (1), which contrasted with all of the other scales using the strongest positive value as the high value (7).

#### Survey Response Rates and Response Demographics

Survey Response Rates. Due to limited time constraints, only one iteration of surveys was sent to the field. As previously mentioned, Appendix A contains the list of maintenance manager addresses. A total of 145 surveys were mailed early in the month of May, 1988. A cutoff date was established on the survey itself to encourage the respondents to return the survey as quickly as possible. Surveys were received up to one month following the cutoff date. Of the 145 mailed, 91 were returned. The raw response rate was therefore 62.8%. However, seven surveys were returned from units that had been deactivated. As the unit deactivation changes were not updated on the mailing lists of Headquarters TAC, these deactivated unit returns were extracted from the overall size of the sample. This resulted in 84 out of 138 usable surveys (60.9%). This response rate was judged as adequate for the type of survey conducted and the time

constraints levied on the respondents. Figure 4.1, below, shows the flow of surveys returned for this research effort.

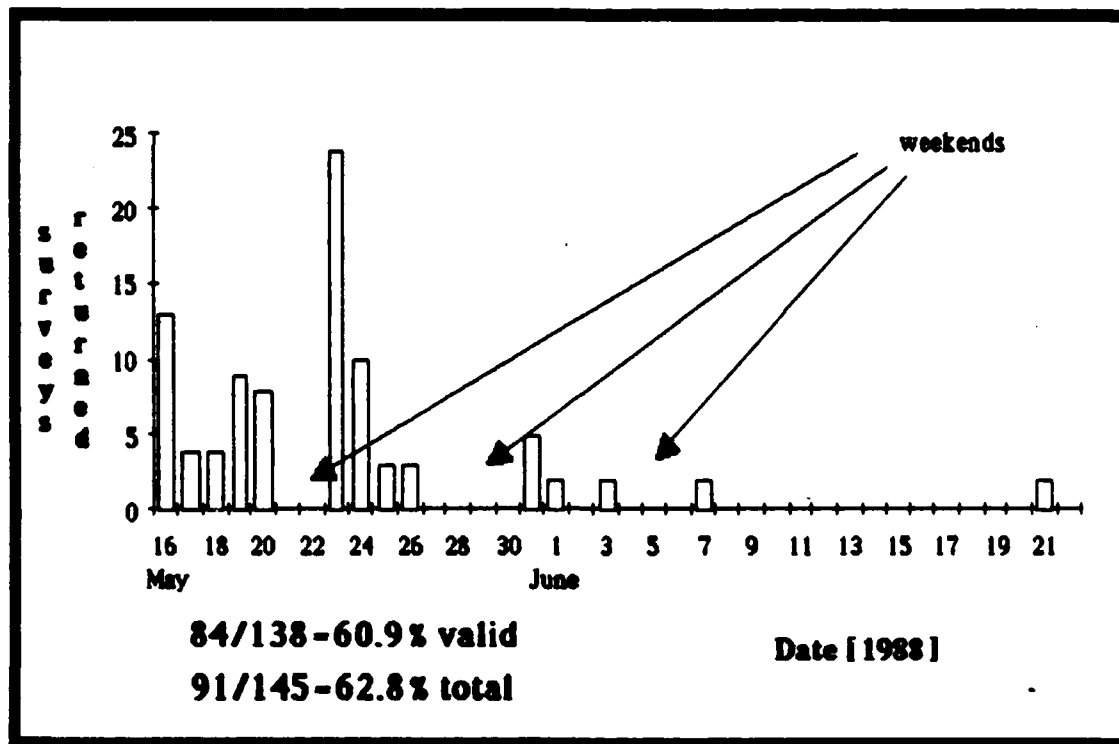


Figure 4.1. Flow of Returning Surveys

A short analysis was then conducted to ensure that the surveys returned were not from any skewed portion of the population. Responses by assistants increased the response rate percentages for the DCM and AGS Maintenance Supervisor categories. The CRS and EMS Maintenance Supervisors do not typically have assigned assistants who are officers, so there was no measured increase in response rate percentages for these last two categories. Nonetheless, any percentage rate above 50% was deemed adequate as per this research methodology. On the next page, Table 4.1 shows the response rates for each of TAC maintenance managers.

**Table 4.1. Survey Response Rates by Manager Type**

	Responses	Sent out	Percentages
*****	*****	*****	*****
Deputy Commanders for Maintenance	26	37	70.27%
*****	*****	*****	*****
AGS Maintenance Supervisors	25	37	67.57%
*****	*****	*****	*****
CRS Maintenance Supervisors	19	36	52.78%
*****	*****	*****	*****
EMS Maintenance Supervisors	14	28	50.00%
*****	*****	*****	*****

**Survey Demographics.** Survey demographics were tabulated in the spreadsheet database. The survey respondents were asked to give the length of time in their present position, the time they worked in the maintenance career field, and the length of time they were assigned in TAC. The responses to the demographics revealed a great amount of information concerning the responding TAC maintenance managers.

Overall, the average amount of time the maintenance managers were assigned to their present position was only one year and one and a half months. The average amount of time the maintenance managers were assigned in maintenance career fields averaged to be ten years and two and

three quarters months. Finally, the average time the maintenance managers spent of their career in the Tactical Air Command was six years and almost nine months. A further breakout by maintenance manager category is included on the following page in Table 4.2. In understanding that the rank structure of the respondents ranged from 2nd Lieutenant to Colonel, the overall time averages for time in the maintenance career field and time in TAC seemed appropriate. As previously shown, there were a total of 84 respondents with 69% of the respondents being Maintenance Supervisors. With the Maintenance Supervisor position normally being a junior Major or senior Captain position, this drove the average years in maintenance and TAC down. Despite this fact, the number of years that all maintenance managers averaged in their present position did appear to be low. No apparent reason for this low average can be deduced from the information collected by this survey. However, this low average could be a factor in determining the degree of institutionalization of R & M 2000 in those managers. If the assumption is present that the managers *were not* exposed to the program in any prior position, then the low time period that the maintenance managers have been in their present jobs *is* definitely a factor. Alternately, if the assumption is present that the managers *were* exposed to the program in any previous job, then the low time period *may or may not* be a factor in determining the institutionalization of the program.

In determining the possibility that these demographics include biases that might influence the factors affecting the degree of institutionalization of the R & M 2000 program, response bias causes were evaluated in the following section.

Table 4.2. Maintenance Manager Average Time Demographics

Time assigned to:	Deputy Commanders for Maintenance		AGS Maintenance Supervisors		CRS Maintenance Supervisors		HMS Maintenance Supervisors	
•• Present Position	1 Year 4.92 Months		1 Year 56 Months		1 Year 72 Months		0 Years 11.85 Months	
•• Maintenance Career Field	13 Years 2.62 Months		10 Years 3.68 Months		7 Years 10.78 Months		8 Years 10.54 Months	
•• Tactical Air Command	6 Years 8.31 Months		5 Years 2.16 Months		5 Years 3.89 Months		4 Years 10.23 Months	

### Survey Response Biases

The survey structure can generate many sources of bias. McClave and Benson list several causes of survey bias (17:919). The applicable causes are listed as follows:

1. Sampling operations,
2. Understanding of concepts,
3. Lack of knowledge,
4. Concealment of the truth,
5. Loaded questions, and
6. Processing errors.

In first discussing the sampling operations, no problems of bias should have arisen in this survey. No part of the sub-population was omitted from the survey. All Deputy Commanders for Maintenance, as well as Chiefs of Maintenance of smaller units, were surveyed. All Maintenance Supervisors were surveyed. In essence, a census was performed. The surveys received did not show any tendency of skewedness toward any part of the sample. As such, the categories of maintenance managers were not biased. Additionally, only three large units had less than 50% response. Six small units had less than 50% response, but of that group of units, the same maintenance manager did not always respond. This gave a better randomness of answers for all of the categories. In short, 75.7% of the units queried had a 50% or better response rate. Still further, 56.5% of the 23 large units had a 75% or better response rate and 50.0% of the 14 small units received a 66.7% or better response rate. Of further note, *no* unit across the Tactical Air Command did not respond with at least one survey return!



The second possible bias of "understanding the concepts" means that the respondents may not understand exactly what is being asked of them by the survey. If they did not understand the program or the questions, then the survey instructed them to not answer that particular question. This happened in several cases to the point where non-response on some of the questions did show some influence on the conclusions that could be deduced from the answers from any remaining respondents. It should be recalled that pretesting was accomplished as a control on this bias. Further discussion of this point is included later in the findings section of this chapter.

The third possible response bias, "lack of knowledge," ties closely to the second. Again, if the respondent was not aware of the concept or simply was not knowledgeable about a facet of a particular question, the respondent was instructed to not answer that question. In one particular case, a maintenance manager even wrote notes in the margin explaining that the respondent did not know about several of the R & M 2000 concepts, so the respondent just stopped answering the remaining questions and returned a nearly incomplete survey. This type of response did not cause any bias, it just added information to assist in determining the degree of institutionalization of the concepts.

Concealment of the truth is always a critical problem with surveys. The surveys for this research were treated as confidential and no attribution to specific individuals are included in this thesis. Also, as previously stated, the attached letter from the TAC Director of Maintenance Engineering was designed to encourage responses that would show the respondents experience and knowledge of flightline operations (see Appendix B). Still

further, the wide range of negative or low responses from the respondents shows that no apparent fear of telling the truth was evident.

The fifth possible cause of bias by loading questions was not evident in this survey. The approval process of the survey and the backwards wording of some of the questions encouraged accurate and unbiased questions. As will be further discussed in the findings section of this chapter, no apparent skewness of the responses in any question was seen.

The final problem of possible response bias was considered to be minimal. Processing errors were checked for at least three times while the database was being constructed. Validity checks of the data were also used to ensure the input data was properly ranged on the seven-point Likert scales. When the charts of modes were created, summation checks were conducted to ensure that the total number of responses totalled the number of respondents in each maintenance manager category.

With all of the possible causes of bias being strongly attacked in this survey, it was concluded that the types of bias evaluated were not considered to be factors in evaluating the data responses.

#### Recording of Findings and Statistical Tests

In recording the survey findings, a three step approach was used. First, the medians of the questions per maintenance manager category were determined. Next, the modes of the questions were determined. The medians and modes were recorded in a comparison table included in Appendix C. As stated earlier in the Methodology chapter, median or modal values varying by two or more were cause for further statistical analysis.

This additional analysis led to the third step of conducting Kruskal-Wallis *H* Tests to statistically determine the similarity of the probability distributions of the survey response categories. Overall, the survey findings were grouped by research questions. In discussing the responses to questions within each survey section, questions with similar emphasis are discussed together.

Program Implementation Survey Responses. [Section 1] This section of the survey was primarily designed to draw out information concerning the degree of institutionalization that could be determined after evaluating the implementation process of the R & M 2000 program. The median and modal comparison table was first evaluated to determine any questions throughout this section of the survey that did or did not have the necessary consensus of opinion. Questions 4, 5, 9, 10, 15, 18, 20, 21, 24, and 28 resulted in consensus. However, this did not mean that these questions were finished being evaluated. Several of these were tied to other questions to draw out a different aspect or more information about a particular concept.

Two scales were used for this section of the survey. Questions 1 through 19 used an extent scale with values shown on the next page in Figure 4.2. Questions 20 through 28 were worded to use the agree/disagree scale, also shown in Figure 4.2. As seen in the figure, in both cases, the lower side of the scale carried negative or small values; the higher side of the scale used positive or large values.

- |                                      |                             |
|--------------------------------------|-----------------------------|
| 1. To a very little extent           | 5. To a fairly large extent |
| 2. To a little extent                | 6. To a great extent        |
| 3. To a moderate extent              | 7. To a very great extent   |
| 4. Neither moderate nor great extent |                             |
|                                      |                             |
| 1. Strongly disagree                 | 5. Slightly agree           |
| 2. Moderately disagree               | 6. Moderately agree         |
| 3. Slightly disagree                 | 7. Strongly agree           |
| 4. Neither disagree nor agree        |                             |

**Figure 4.2. Survey Response Scales (Section 1)**

**Statistical Tests.** The Kruskal-Wallis  $H$  test was conducted for all questions. The alpha (" $\alpha$ ") values denote the confidence level associated with the conclusion of the statistical tests. With an " $\alpha$ " of 0.05, it could be stated that one would be 95% confident that the distributions were identical or different. On the following page, Table 4.3 shows the  $H$  test results for this section of the survey at both the 95% and 99% confidence levels. The observed values were compared with the test statistics to see if they fell in the rejection region. If they did, then the null hypothesis was rejected and the distributions were considered different. If the observed values fell below the critical value of the test statistic, the null hypothesis could not be rejected and the distributions were considered the same.

**Question 1: I get involved with the R & M process.** The median value for each of the maintenance manager categories varied greatly. The DCMs had a value of 5 (to a fairly great extent) whereas the remainder of

**Table 4.3. Kruskal-Wallis H Test Results (Survey Section 1)**

**H<sub>0</sub>: The 4 probability distributions are identical**  
**H<sub>a</sub>: At least 2 of 4 distributions differ in location**

**Rejection Region: ( $\alpha = .05$ )  $H > 7.81473$**

**Rejection Region: ( $\alpha = .01$ )  $H > 11.3449$**

**[3 degrees of freedom]**

<b>Question #</b>	<b>Observed H</b>	<b><math>\alpha=.05</math></b>	<b><math>\alpha=.01</math></b>
1	17.1253	DIFFERENT	DIFFERENT
2	5.1906	SAME	SAME
3	1.7959	SAME	SAME
4	3.2076	SAME	SAME
5	3.8478	SAME	SAME
6	12.9343	DIFFERENT	DIFFERENT
7	7.8449	DIFFERENT	SAME
8	9.7987	DIFFERENT	SAME
9	9.0933	DIFFERENT	SAME
10	3.1082	SAME	SAME
11	4.1450	SAME	SAME
12	3.6885	SAME	SAME
13	5.0499	SAME	SAME
14	5.4247	SAME	SAME
15	3.1903	SAME	SAME
16	24.1996	DIFFERENT	DIFFERENT
17	11.0623	DIFFERENT	SAME
18	5.2304	SAME	SAME
19	6.0483	SAME	SAME
20	3.5782	SAME	SAME
21	6.1927	SAME	SAME
22	4.9304	SAME	SAME
23	13.4925	DIFFERENT	DIFFERENT
24	6.3966	SAME	SAME
25	5.6553	SAME	SAME
26	4.0601	SAME	SAME
27	6.0273	SAME	SAME
28	7.1342	SAME	SAME

the Maintenance Supervisor categories resulted in median values on the bottom of the scale, ranging from 1 (to a very little extent) to 3 (to a moderate extent). The modal values showed consensus amongst the Maintenance Supervisors, all with values of 1. The DCMs again differed with a modal value of 6. Figure 4.3 (duplicated from Figure D.1) shows the modal charts for this question. Because of the range of responses, the  $H$  test was required to show that the distributions were indeed different. The statistical test revealed that with 95% and 99% confidence, at least two of the four distributions could be considered different (see Table 4.3).

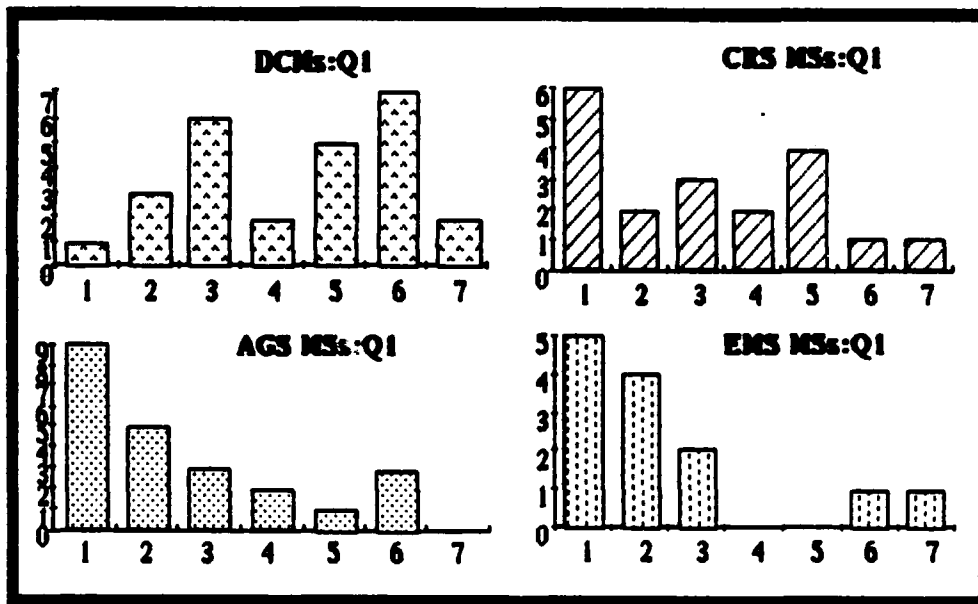


Figure 4.3. Section 1, Question 1 Survey Response Histograms

Overall, the emphasis of this question was to initially find out if the maintenance managers got involved with the R & M process at all. Additional questions elaborated on how the managers could possibly get

involved, but this question was aiming at a broad perspective of the maintenance managers level of involvement with the process. A possible explanation offered for the difference between the DCMs responses and the Maintenance Supervisors could be that the DCMs are simply a level of management higher than the Maintenance Supervisors. The Maintenance Supervisors may not feel that their individual efforts are related to the R & M process, as opposed to the DCMs seeing the 'whole picture' and running the maintenance organization. As such, the DCMs directly feel their own impact on the R & M process. Oftentimes, the DCMs solve disputes between the squadrons and as a result, set the standards for the DCM complex. This standard usually addresses the R & M precepts, but because each Maintenance Supervisor may not see his or her contribution in the final standard, they ultimately may not feel that they get involved with the process. As will be seen later, other survey responses conflict with this initial statement that the Maintenance Supervisors get involved to a very little extent.

Questions 2, 3, & 4: I plan the daily operations in my unit; I organize the daily operations in my unit; and I control the daily operations in my unit.

Many organizational managers get involved in any program by planning, organizing, and controlling the operations of their units. The daily operations are usually very specific and the expected trend of these questions was that the Maintenance Supervisors would plan, organize, and control the daily operations on the high positive side of the scale, showing a possible value of 6 (to a great extent). It was expected that the DCMs would plan, organize, and control still on the high side of the scale, but with a

slightly lower value, possibly of 5 (to a fairly large extent). Only one of these three questions showed results as expected.

Planning (Question 2). In planning daily maintenance operations, the AGS and CRS Maintenance Supervisor categories tended toward the high side, both showing medians of 5. The EMS Maintenance Supervisors' responses had a median value of 3.5, indicating a slight trend toward the lower side of the scale with some values remaining on the high side. The modal values were basically the same with all Maintenance Supervisors having a 5 as a mode. However, the EMS Maintenance Supervisors additionally showed a secondary mode of 3 on the other side of the scale. The DCMs also showed a similar tendency with the dual modal responses of 5 and 3. Figure D.1 displays the modal response charts for question 2. The *H* test was again required to statistically show that these distributions were different. However, with a 95% or 99% confidence level, the null hypothesis could not be rejected and two of the four distributions could not be regarded as being different (see Table 4.3).

An explanation for the tendencies of the DCMs and EMS Maintenance Supervisors would be that sometimes these maintenance managers are in more of a reaction mode of management than the other two Maintenance Supervisors. Daily flightline and test equipment operations often generate the work for several of the shops in EMS. The DCMs set policy, but also *react* to the daily sorties and avionics units repair actions. Further research should be accomplished to determine more in depth reasons for the planning differences or similarities between all of the maintenance managers.



Organizing (Question 3). The responses to this question were similar to that of the planning question. The median value for the DCMs' responses was 4.5. The AGS and EMS Maintenance Supervisors both had medians of 4, and the CRS Maintenance Supervisors had a median value of 5. The modal values, however, showed a great disparity between all of the categories. The DCMs again displayed dual modal responses of 3 and 5. The AGS Maintenance Supervisors showed a strong modal value of 5. However, both the CRS and EMS Maintenance Supervisors responded with a lower degree of consensus. The CRS Maintenance Supervisors incurred tri-modal response values of 2, 3, and 5. These scale values only had four respondents each. The scale values of 4 and 6 also had three respondents each. As such, the CRS managers did not agree on the level of organizing the daily operations of their unit. The EMS Maintenance Supervisors had a similar modal distribution as question 2, but the dual modal response dropped to a single mode of 3. There was also some degree of non consensus with these supervisors as the number of respondents for any scale value was never more than four. Figure D.2 shows the modal values for this question. Still again, the  $H$  test was conducted to conclude that at least two of the four populations differed in their probability distributions. The results of the  $H$  test were not conclusive as the distributions were statistically shown as being the same (see Table 4.3).

Why the DCMs, CRS, and EMS Maintenance Supervisors showed no consensus concerning the organizing of the daily operations of their unit is unknown. It is possible that the flying schedule, which is generated usually in the Aircraft Generation Squadron, controls the organization of the daily

operations of the other units. This possible reason reinforces the relatively high response mode of the AGS Maintenance Supervisors, where they feel that they, to a fairly large extent, *do* organize the daily operations in their units. However, this reason does not provide a sound justification as to why the other maintenance managers showed no consensus. Continued research in this area may uncover some valid reasons for the disagreements.

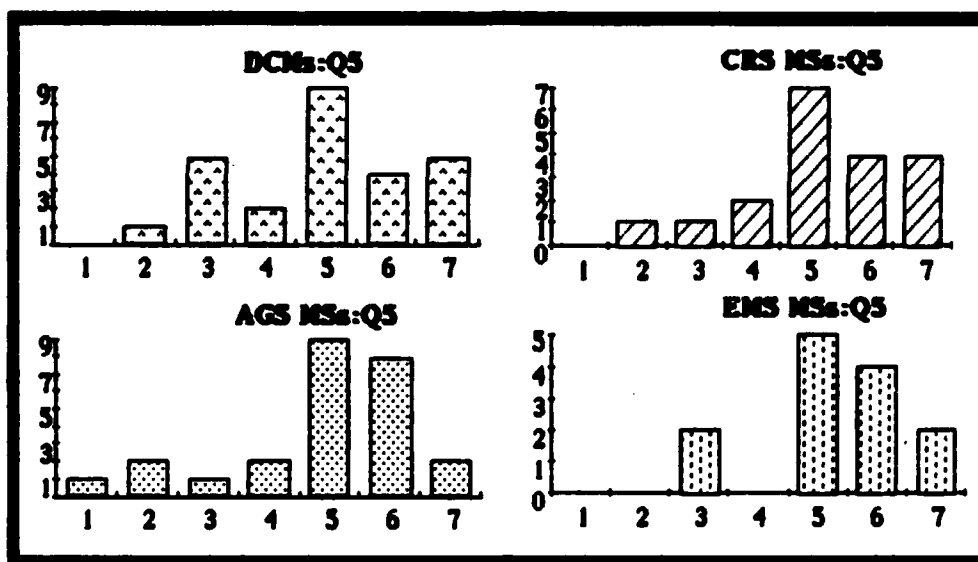
Controlling (Question 4). Only the responses from this question followed the expectations for these three 'getting involved' questions. All of the maintenance manager categories showed a median value of 5. The modal values only varied by one scale value in only one case. The CRS Maintenance Supervisors showed a modal value of 6; the remaining managers showed consensus with a modal value of 5. Figure D.2 indicates the modal histogram distributions for this question. With general consensus on this question, no *H* test was required to show the distributions might be different. The accomplishment of the *H* test anyway verified that the distributions were all the same at the 95% and 99% confidence level.

To understand an explanation for the differences between the planning and organizing question responses and the controlling question responses, it must be understood that *planning* and *organizing* both require advance timing. In other words, the actions required for a unit to *plan* and *organize* their daily operations must be forseen and developed beforehand, not in a reactionary mode. In contrast, to *control* a unit's actions, a reactionary management style may be used. As such, all of the maintenance managers may feel that they can react sufficiently to any daily occurrences and control the operations of their units.

**Question 5: My job provides freedom and independence in selecting my own procedures to accomplish my work.** The emphasis of this question was to drive a little deeper into the planning, organizing, and controlling concepts. It could be hypothesized that if a manager plans, organizes, and controls his unit's operations, then he may have the freedom to choose his own way of accomplishing any actions he may deem necessary. Since there were no general agreements between the planning and organizing questions, it follows that it would be very difficult to make any substantial conclusions of a more in depth question.

It is puzzling, therefore, that this question received the best consensus of the first five questions. The median and modal values were all the same with values of 5. On the following page, the histograms in Figure 4.4 (duplicated in Figure D.3) display the similar distributions between all of the manager categories. Because of the strong consensus between all of the categories, the  $H$  test was not necessary. Despite the fact that the statistical test was not necessary, it was accomplished to check the methodology of this research. Looking at the  $H$  test values from Table 4.3, the methodology of allowing a question with less than two values of variance in the modes and medians to be considered to have identical response distributions is validated. For this question, at neither the 99% nor 95% confidence level could the null hypothesis be rejected, thus indicating the distributions were the same.

The dimensions of change that Levy described come into play with these five questions and provide a better explanation for the inconclusive and puzzling nature of the first four questions and the strong consensus with the



**Figure 4.4. Section 1, Question 5 Survey Response Histograms**

fifth question. The first question of involvement in the R & M process was aimed at the mission level. The concept of involvement was vague and the responses showed some tendency toward that vagueness. The second, third, and fourth questions were a little more concrete and were aimed at Levy's "culture" level. The responses to these questions may have varied because the organizational beliefs, values, and norms usually differ from unit to unit. The fifth question was designed to probe the core processes of the maintenance managers. Complete consensus was obtained when the question was more specific and detailed with exact references to the managers' jobs and their own impact on accomplishing those jobs.

To continue this type of analysis, question 6 was asked to again probe the mission dimension. Questions 9 through 12 and 15 aimed at

the culture level, and questions 13, 14, 16, 20, and 21 strived to uncover their core processes.

Question 6: I am aware of the guidelines of the R & M 2000 Program.

As the R & M 2000 program is a higher level directed program, and is supposed to be incorporated in all facets of maintenance, the expectations for the responses for this question were that the maintenance managers possessing the direct responsibilities for maintenance production and operations should be aware of the guidelines of the program to at least a great extent.

The opposite of this hypothesis was true. Generally, the DCMs were not in agreement as their median was 4.5 with dual modal values of 4 and 5. The distribution was spread out across the entire scale with no strong modal hump showing strong consensus. This indicated that a few of the DCMs were aware of the R & M 2000 guidelines to a great extent. On the other hand, the Maintenance Supervisors all showed a tendency toward the lower side of the scale. The AGS and EMS Maintenance Supervisors incurred modal values of 1, with the CRS Maintenance Supervisors showing a mode of 2. The AGS Maintenance Supervisors were not in complete agreement though, as seen by the second modal value of 5; this causing the median value to raise to 4. The median values for the CRS and EMS Maintenance Supervisors were 3 and 2 respectively. The  $H$  test was conducted to statistically show the probability distributions were indeed different. This was true at both at the 95% and 99% confidence levels (see Table 4.3). Figure D.3 displays the survey response histograms for this question.

With this question aiming at the higher mission dimension, it was designed to be slightly vague with little or no specifics. As such, no total agreement was found representing a consensus of feelings of the maintenance managers, shown by responses falling on both sides of the scale for various managers. To move to the next level of culture, more specific stated goals are needed. In the R & M 2000 program, goals are specified in order of precedence. The following five questions were designed to ask more detailed questions concerning the goals of the program.

Question 9: I have control/get involved with increasing the combat capability of my unit. The first goal of R & M 2000 was to increase the combat capability of any unit. Consequently, the emphasis of this question was to directly detect the degree to which the maintenance managers felt that they contributed to any increase on that combat capability. All maintenance managers categories were expected to answer on the high side of the scale for this question. Whether or not the R & M 2000 program was directly being implemented should have not had any impact on any responses for this question. The ultimate goal of the Armed Forces is to provide combat capability to the United States and this should be one of the overall goals of every maintenance manager everywhere.

In this case, all of the maintenance managers responded similarly. The DCMs had a median response value of 6, with the same modal value. The AGS and EMS Maintenance Supervisors both had median and modal values of 5. The CRS Maintenance Supervisors responded with a median value of 5.5 and dual modal response values of 5 and 6. See Figure 4.5 (also

included in Figure D.5) for the modal response charts. As consensus was obtained by all categories, no  $H$  test was required for this question. Nevertheless, the statistical test was conducted and did show some slight conflicting information. At the 95% confidence level, the distributions for this question were considered different. However, at a higher confidence level of 99%, the differences between the distributions were not strong enough to reject the null hypothesis. Just having a slight spread of some of the lower scale responses could have contributed to this statistical conclusion that with 99% confidence, two of the four distributions could not be looked at as being different.

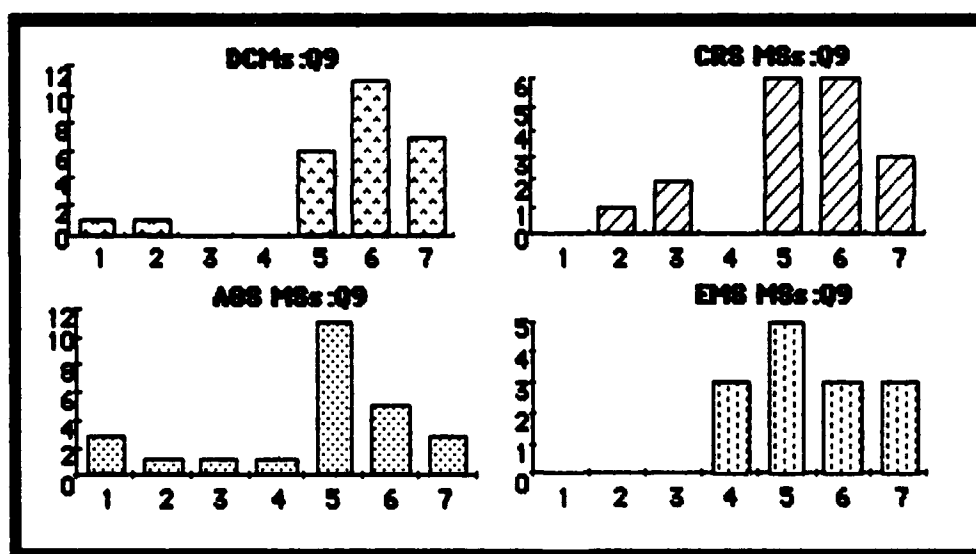


Figure 4.5. Section 1, Question 9 Survey Response Histograms

The results of this question were not surprising. It is most maintenance managers view, and especially in TAC, that their primary job is "to fly and

fight." Increasing combat capability, then, is a natural extension of the maintenance managers perceived primary job.

Question 10: I have control over increasing the survivability of my weapon system. The second goal of the program was to increase the survivability of the combat support structure. It was expected that the responses to this goal would not be as high as the previous question. A suggested reason for this is the understanding of the word survivability. A secondary reason is the unsure definition of a combat support structure.

Not entirely as hypothesized, the response values for this question were low. The DCMs and EMS Maintenance Supervisors responded with median values of 3.5; the modal values were 1 and 2 respectively. The AGS Maintenance Supervisors also responded relatively strongly to the low side. Their median was 3 with dual modal values of 1 and 2. Lastly, the CRS Maintenance Supervisors' responses showed a median value of 2.5 with a mode of 2. As no values of the medians and modes varied by more than one scale value, no *H* test was necessary. Table 4.3 shows again that the statistical test just verified the initial methodological conclusion that consensus was obtained and the distributions were considered the same with a confidence level of at least 95%. Figure D.5 shows this question's survey response histograms.

The reason for the significant drop below the high values of the combat capability question is not clear. Perhaps, the maintenance managers felt that they were not directly part of the combat *support* structure, that they were only directly part of the combat *capability* structure. Further research should be conducted to clarify a reason for this disparity.



Question 11: I have control/get involved with decreasing the mobility requirements for my unit. The third goal of the R & M 2000 program was to decrease the mobility requirements per unit. This question was again expected to result in responses on the high side of the scale. This question should not have been subject to the possible misunderstandings like the previous goal; this goal was worded more straight-forward and clearly.

Opposing viewpoints again arose from the results of this question. The tendency of all managers was generally toward the low side of the scale. The medians all gained consensus with the AGS and CRS Maintenance Supervisors receiving a value of 3, followed by the DCMs with a median of 3.5, and finally followed by the EMS Maintenance Supervisors with a value of 4. Despite this apparent agreement, the modal values varied moderately. The DCMs, AGS and CRS Maintenance Supervisors all had modes of 1. The AGS Maintenance Supervisors value was considered weak as the difference between the mode and two second highest response values of 2 and 4 was just one more manager's response. The EMS Maintenance Supervisors had a modal value of 4 also with second highest responses of 2 and 6 also being just one manager behind. The modal distributions can be seen in Figure D.6. Because of the variation in distributions, the  $H$  test was required. However, the test revealed that the null hypothesis could not be rejected at the 95% confidence level; at least two of the four distributions could not be shown to be statistically different. It followed then, that with 95% confidence, the distributions were viewed as being the same for this question.

The DCMs, AGS and CRS Maintenance Supervisors nearly agreed that they did not get involved in decreasing the mobility requirements for their units. The EMS Maintenance Supervisors responses were generally inconclusive. Overall, a possible explanation is that even though the maintenance managers may not have *felt* that they were getting involved or controlling the mobility requirements, they possibly *actually were* getting involved, just at lower dimension. Again, further research should be conducted to detect any reasons for this significant drop below the first goal of combat capability.

Question 12: I get involved setting manpower requirements for my unit. The fourth goal of the program was to decrease manpower requirements per unit of output. This goal was also somewhat ambiguous in that the definition of decreasing per unit of output was unclear. The emphasis of this question was simply to detect the extent that the maintenance managers felt they set their own manpower requirements for their units. The expected value for this question was again on the high side of the scale, with a possible modal response of 5.

For this question, the median and modal values varied greatly for all manager categories. In this case, the DCMs and the EMS Maintenance Supervisors were basically close to agreement with medians of 5 and modal values of 5 and 6 respectively. The AGS and CRS Maintenance Supervisors were also similar. The AGS Maintenance Supervisors showed a median value of 4, whereas the CRS Maintenance Supervisors showed a median value of 3. Both of these categories resulted in modal values of 3. The AGS Maintenance Supervisors were not considered to be in strong agreement

because of the difference between the primary mode and the second, third, and fourth highest modes being just 2 respondents. An  $H$  test was required to prove that the distributions were truly not the same. Table 4.3 indicates that the alternate hypothesis that the distributions were different could not be verified statistically. At the 95% confidence level, two of the four distributions could not be proven to be different. Figure 4.6 (also shown in Figure D.6 in Appendix D) displays the variation in modal responses.

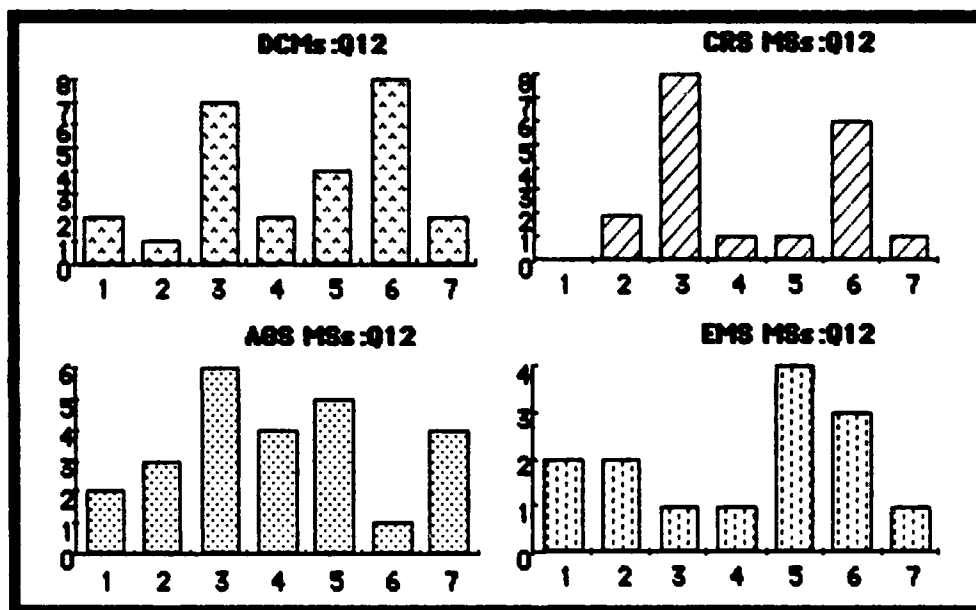


Figure 4.6. Section 1, Question 12 Survey Response Histograms

At this level of analysis, no reasons could be detected for the apparent disagreements between the DCMs and EMS Maintenance Supervisors vice the ABS and CRS Maintenance Supervisors. Still again, further research should be conducted to determine concrete reasons why this question overall did not get the expected high value responses.

Question 15: I have control over decreasing R & M costs. The final goal of the R & M 2000 program was to reduce costs. As with all of the other goals, the expected response should be on the high side of the scale. As the emphasis has always been on reducing costs, the modal value of this question was anticipated to be to a great extent (6).

Once more, the results of this question were in direct opposition of the expectations. Across the spectrum of maintenance managers, the median values remained the same at 2 (to a little extent). All categories had strong modes of 1. The CRS Maintenance Supervisors also had a second mode of 2. Complete consensus of attitudes of the maintenance managers was seen on this question. No statistical *H* test was necessary. At both confidence levels, Table 4.3 verifies that the null hypothesis could not be disproved and that the distributions were considered to be statistically the same. Figure D.8 shows the modal response histograms for this question.

No explanation for this recurring trend of the last four goals being well below expectations can be offered. After the next level of change dimension is completely analyzed, possibly more conclusive evidence may be uncovered. It is significant to note at this time that the basic understanding of the goals of the R & M 2000 program cannot be detected from these questions. Only the extent that the maintenance managers felt that they could control or get involved in the process could be determined. Naturally, an initial conclusion that if the maintenance managers were only getting involved in one of the five goals to any significant level greater than a little extent, it might be very hard for the entire program to be institutionalized to any great degree.

Undoubtedly, the next step was to look deeper into Levy's core processes dimension. As previously mentioned, the next five questions were constructed to gather more specific information from the maintenance managers with respect to the core process implementation of the program goals.

Question 13: I have free rein to adjust shop/section size to better meet the needs of my unit. This question was designed to better measure the emphasis of the third and fourth goals of decreasing the mobility and manpower requirements. It was hypothesized that possibly maintenance managers might have answered to a low extent on the higher level question, whereas in actuality, they may indeed accomplish the actions necessary to satisfy the requirements of the goals just at a lower dimension.

As can be seen from Figure 4.7 on the following page, virtually no agreement was evident in any maintenance manager category. The medians only varied slightly, from 2 for the EMS Maintenance Supervisors, to 3 for the DCMs, and finally to 4 for the AGS and CRS Maintenance Supervisors. This, however, gave a misleading idea of the distributions of the responses. The wide variations in the modes, from 2 to 7, showed a significant lack of consensus. In all cases, the modes were weak with the second highest modal value being just one respondent behind. The presence of a quad-modal response histogram for the AGS Maintenance Supervisors reinforces the lack of agreement. The  $H$  test was definitely required to conclude the distributions were statistically different. However, at least at the 95% confidence level, this could not be proved. The null hypothesis could not be rejected to statistically indicate that at least two of

the four distributions were different. A possible reason offered for the lack of ability to statistically show the distributions as being different would be the low numbers of responses for any maintenance manager category. Therefore, the *H* test rank sums could not show strong enough variations between the categories.

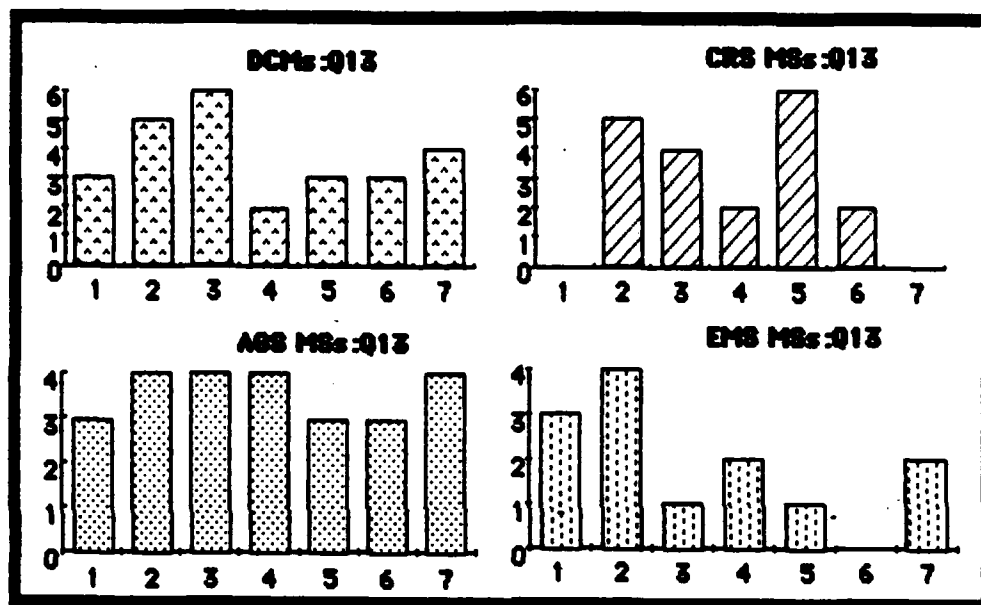


Figure 4.7. Section 1, Question 13 Survey Response Histograms

The rationale behind this wide expanse of responses is unknown. Being able to adjust or not adjust the size of their shops freely may be because of the next level higher of management. Some supervisors do not allow the squadron structure to be flexible. In total, this question does show that no conclusions can be made concerning the core process of institutionalizing the third and fourth goals of the program.

Question 14: I actually review and adjust, on a frequent basis, the manning and skill level requirements for my unit. The design of this

question was to supplement the previous question concerning the extent of getting involved with the third and fourth R & M 2000 program goals. It was hypothesized that the DCMs might respond slightly lower on the scale than all of the Maintenance Supervisors. The reason for this would simply be the one level of management higher in which the DCMs fall.

The median values for this question were again misleading. The values of 3 and 4 did not indicate the dispersion of the responses within each category. The modal values shown in Figure D.7 indicate a weak similarity between the Maintenance Supervisors. The AGS Maintenance Supervisors tallied a modal value of 2, the CRS Maintenance Supervisors had a mode of 2 and the EMS Maintenance Supervisors responded with a modal frequency of 3. None of these modes were strong. On the other hand, the DCMs responded without consensus at all. The tri-modal responses of 3, 5, and 6 attest to this statement. The *H* test was necessary to validate the statistical variations between the probability distributions. As previously was the case, at the 95% confidence level, the differences between the distributions could not be detected. Table 4.3 shows the null hypothesis was accepted at both confidence levels tested.

Despite the *H* test results, this question does provide some evidence that at least the Maintenance Supervisors have institutionalized the core processes of the mobility and manpower goals to at least a low extent. Further research is necessary to determine any reasons for this low extent of institutionalization of the third and fourth R & M 2000 goals.

Question 16: I *actually* control the O & M budget in my unit. This question was specifically designed to determine if the maintenance managers were responsible for controlling the day-to-day budgets in their units. If they were, then it was hypothesized that the R & M 2000 goal of decreasing costs could indeed be met. If they were not, then this could be justification for any low responses at the higher level for the cost goal question (#15).

Figure 4.8 on the following page shows the relative agreement of the Maintenance Supervisors and the opposing responses of the DCMs. The DCMs responded with a median of 5 and a mode of 6. This indicated that they did actually control the budgets from a fair to great extent. Alternately, all of the Maintenance Supervisors showed consensus at the other end of the scale. The AGS and EMS Maintenance Supervisors had a median value of 2 and a modal value of 1. The CRS Maintenance Supervisors responded at a higher level with values of 3 for both the median and mode. As the DCMs showed significant disagreement with the Maintenance Supervisors, the  $H$  test was conducted for statistical validation of the different distributions. The CRS Maintenance Supervisors differences also contributed to the requirement of the statistical test. At both the 95% and 99% confidence levels, the null hypothesis was rejected. The observed  $H$  value of 24.1996 was significantly strong enough to allow the statistical conclusion that at least two of the four distributions were different.

From the results of this question, two conclusions could be proposed. As seen from question 15, all of the maintenance managers responded



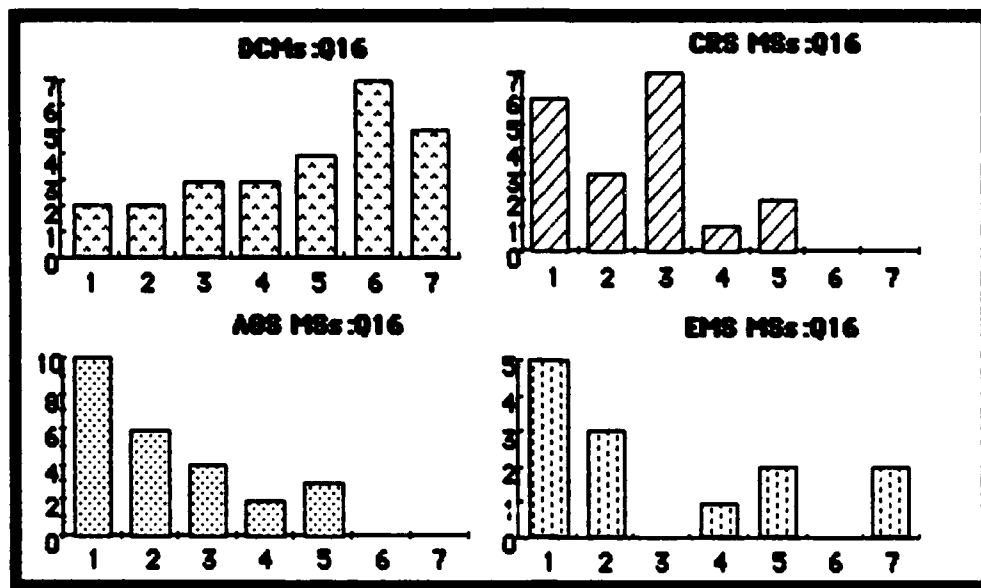


Figure 4.8. Section 1, Question 16 Survey Response Histograms

exhibiting a strong low response of control over decreasing R & M costs. Thus, the first conclusion is that the DCMs are inconsistent with their responses. They responded that they did not control R & M costs, but they did control the O & M budget. This conflicts as it should follow that if the DCMs control the O & M budget, then decreases in R & M costs could be realized. Apparently, by this conclusion, the DCMs had control at the core process, but they were not aware of the higher dimension that they also controlled. It should be noted that the DCMs could be considering that the O & M budgets that they did control did not include any references to R & M type actions or items. If this was true, then there can be no conclusion drawn from their core process answer.

This, however, was not the case with the Maintenance Supervisors and is the basis of the second proposed conclusion. The Maintenance Supervisors felt that they did not control the R & M costs or the O & M

budget. This might be considered slightly unusual. As required by TAC Regulation 66-5, the Maintenance Supervisors in all squadrons are responsible for monitoring the maintenance resources of the squadron. To this end, most squadrons incorporate the duties of a Resource Advisor with an assistant Maintenance Supervisor or Superintendent. These Resource Advisors are responsible for specifically controlling the budgets of the squadrons. Cost centers are usually established at lower levels than the Maintenance Supervisors, but they make inputs to the Resource Advisor regularly. Thus, some confusion could exist as to whether the Maintenance Supervisors felt, when they only received inputs and usually didn't adjust budget figures, that they were not *controlling* the costs. Further research in this arena may better define the aspects of R & M costs that can be controlled.

Question 21: I impact the R & M costs in my unit. To further solidify the conclusions of the previous cost questions, another question was asked later in the survey to see if the maintenance managers felt they impacted the R & M costs in their unit differently after they had answered more questions and thought about the cost concept longer.

The previous cost related responses generally tended toward the lower side of the extent scale. Opposite responses resulted from this question. The DCMs and CRS Maintenance Supervisors both had medians of 5 and the AGS and EMS Maintenance Supervisors both had medians of 4. These medians gave a good indication of the distributions. The modes reinforced this indication. The DCMs, CRS and EMS Maintenance Supervisors all displayed modes of 5. The DCMs also had a dual mode of 4. Additionally,

the AGS Maintenance Supervisors had a dual mode of 4. As the median and mode did not vary by more than two scale values, the distributions were considered the same and the *H* test was not required. Once again, Table 4.3 validates the methodology showing the distributions to be the same at both confidence levels. Figure D.11 in Appendix D shows the modal frequency charts for this question .

These results contradict the previous responses. The tendency in this case is towards the higher side of the scale with at least a fairly large extent response from all categories. Why the maintenance managers felt that they did not have *control* over decreasing costs, but that they did *impact* the costs is perplexing. If the managers *impacted* the costs, would they not at least occasionally be decreasing those costs? The confounding opposite responses for these cost questions should elicit further research to determine the extent of involvement of the TAC maintenance managers in the cost process. Only then could any sound conclusions be made concerning the institutionalization of the fifth goal of the R & M 2000 program.

Question 20: Survivability is an important R & M goal in peacetime operations. The purpose of this fifth core process question was to delve deeper into the second goal of survivability. Its intent was to just question the maintenance managers as to whether they felt the goal was important. This would not contradict the previous question of the extent of the maintenance managers *controlling* the survivability of their weapon system. It would just validate the importance of the goal.

This question resulted in complete consensus from all categories of managers. As can be seen below in Figure 4.9, the modal responses were all strong 7s. The medians ranged from 6 for all of the Maintenance Supervisors to 6.5 for the DCMs. As such, no *H* test was necessary for this question.

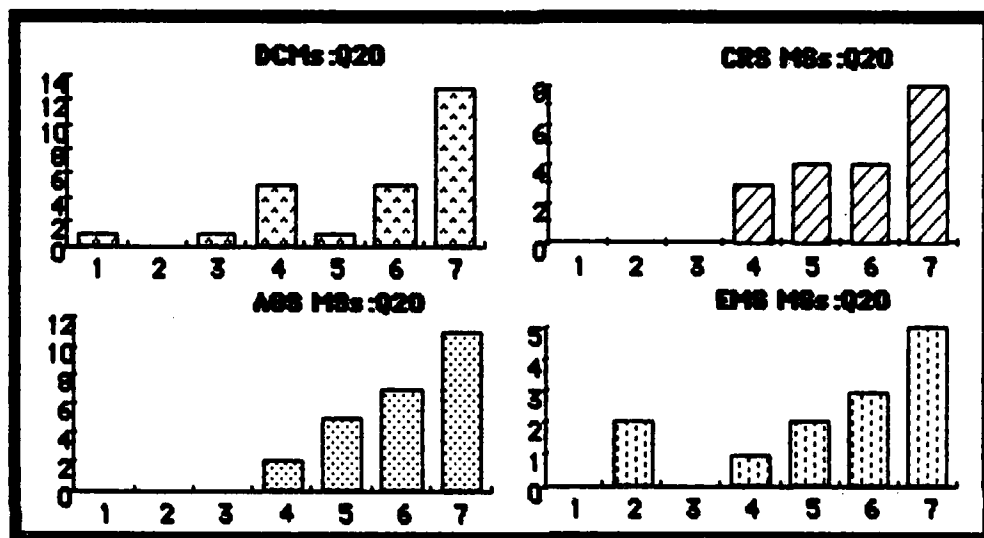


Figure 4.9. Section 1, Question 20 Survey Response Histograms

As previously mentioned, this question's results do not contradict with the previous low responses on the higher dimension survivability question. It simply indicates that the maintenance managers felt that they strongly agreed that survivability was important, not that they had any control over changing it.

The remaining questions in section 1 were all designed to probe further intricacies of the core processes. More information was gathered from questions 7, 8, 18, 19, 22, 24, and 27 concerning general involvement in the program. These questions investigated to what extent the implementation

of the program was institutionalized in the maintenance managers themselves. Additionally, questions 17, 23, 25, 26, and 28 were designed to detect how much emphasis the maintenance managers placed on the program and how well they incorporated the program into their units.

Questions 7 & 8: My weapon system demands my involvement with R & M decisions; I actually get involved with R & M decisions. To reiterate, both of these questions were aimed at the core process dimension, including more specific details regarding the first question involvement. The first of this set of questions was designed to detect if the maintenance managers were aware that their system needed their involvement in the R & M process. The second question was asked to determine the extent that the managers actually got involved. It was expected that since the responses for the first question were relatively high for the DCMs and relatively low for the Maintenance Supervisors, that these questions should follow the same suit.

Weapon System Demanded Involvement (Question 7). With question 7, the medians were generally higher than question 1. In this case, the DCMs, CRS and EMS Maintenance Supervisors all resulted in 4s for their medians. The AGS Maintenance Supervisors showed a median of 3. Despite this slight shift higher for the medians, the modes were very similar to the first question. The DCMs had the same mode of 6; all of the Maintenance Supervisors had a mode of 1. In addition, the CRS and EMS Maintenance Supervisors incurred second modes of 5 and 4, respectively. This indicated that these two groups of responses were not as strong as the other two. A significant number of respondents for all categories answered

on the opposite side of the scale from the modal values. In the DCMs case, fourteen out of 26 responded at the scale level of 4 or below with the mode being 6. Similarly, 12 of the 25 AGS Maintenance Supervisors answered at the level of 4 or above with the mode of 1. The CRS and EMS Maintenance Supervisors paralleled this tendency. Figure D.4 charted the frequencies of the responses for this question. As no complete consensus was obtained, the *H* test was once more necessary. The *H* test revealed interesting results. At the 95% confidence level, the null hypothesis was rejected. However, at the 99% confidence level, the null hypothesis could not be rejected. The observed *H* value was just slightly higher than the 95% test statistic, but lower than the 99% test statistic. Thus, at the higher confidence level, the alternate hypothesis that at least two of the four distributions were different could not substantially be proved. As in a previous case, the low numbers of responses at any scale value contributed to the inability to show statistical differences between the categories.

An analysis of this question indicates that the maintenance managers did not feel as strongly on either side of the scale that their weapon systems *demand*ed their involvement in R & M decisions. To possibly find a reason, question 8 was evaluated.

Actual Involvement (Question 8). This question more nearly mimicked the responses of the higher dimension question concerning involvement. The DCMs replied with a median of 4 and a mode of 6. Though the median was lower, the mode was actually stronger than in question 1. The medians for the other categories were 1, 2, and 3, for the AGS, CRS, and EMS Maintenance Supervisors, respectively. As seen in

Figure 4.10, the modes for all three categories were strong 1s. Inasmuch as the DCMs differed from the Maintenance Supervisors, the  $H$  test was conducted to verify that the distributions were not the same. The results of the  $H$  test were similar to those of question 7. At the 95% confidence level, the distributions were considered different, but at the 99% confidence level, insufficient proof was available to still conclude the distributions were not identical. The spread of responses for the EMS Maintenance Supervisors may have been a contributing factor for the inability of the statistical test to prove the distributions were indeed different at the higher confidence level.

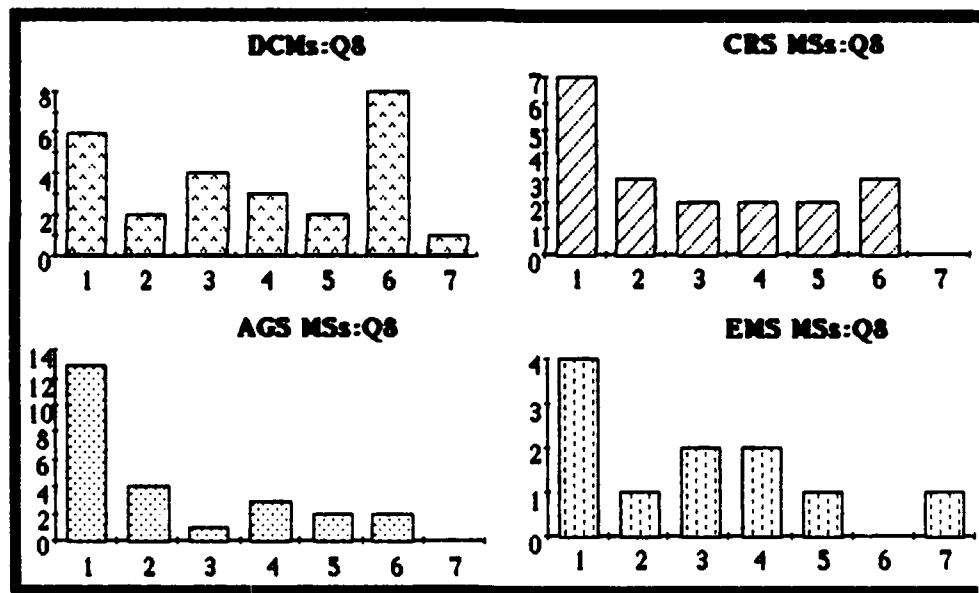


Figure 4.10. Section 1, Question 8 Survey Response Histograms

The results of this question were not unexpected. The higher dimension question was basically validated by this core process question. Overall, the DCMs felt that they did get involved, whereas the Maintenance Supervisors strongly felt as a group that they, to only a little to moderate extent, got

involved in R & M decisions and the R & M process. As a result, the extent of institutionalization at the program implementation stage could be considered to be generally lower than expected.

Questions 18 & 19: I track *critical* maintenance actions to ensure that they do not adversely affect my unit's mission; I track *common* maintenance actions to ensure that they do not adversely affect my unit's mission. The intent of these two core process questions was to discover the extent that the maintenance managers in TAC got involved with even more specific actions directly related to their jobs.

Critical Maintenance Actions (Question 18). Complete consensus was obtained on this question. The medians only ranged from 6 to 7 and the modes followed the same trend. As can be seen from Figure D.9, all responses were strong. No *H* test was required for this question. The test was still conducted to again validate the methodology. This question's *H* test results in Table 4.3 did verify the validity of the methodology concerning median and mode consensus.

An obvious explanation for these responses is that all of the maintenance managers felt to at least a great extent that one of their primary jobs or responsibilities was to monitor any abnormal actions in their organizations. The critical maintenance actions that may affect their combat capability were deemed important to the success of their units.

Common Maintenance Actions (Question 19). The responses to this question did follow expectations of the responses from the TAC managers. It was predicted that not as many DCMs would get involved in the process to track common maintenance actions. Some were still



anticipated to track the actions because it was stated that these actions were such that they might infringe on the unit's mission.

Not quite as predicted, the DCMs did not show consensus with this question. The Maintenance Supervisors generally did still feel that they still got involved as seen by their medians and modes of 5s and 6s. Shown in Figure D.10, the DCMs responded with a median of 5, but spreading out with a quad-modal response of 3, 5, 6, and 7. The AGS Maintenance Supervisors tallied both a median and mode of 6. The CRS and EMS Maintenance Supervisors both had medians and modes of 5. As the DCMs disagreed on their extent of tracking the common maintenance actions, the  $H$  test was required. As only one of the maintenance manager categories significantly disagreed, the  $H$  test did not find sufficient evidence to conclude that at least two of the four distributions were different. At both levels of confidence, the  $H$  test concluded the distributions were the same.

The results of this question showed that typically, the DCMs stayed one level of decision making higher than that of the Maintenance Supervisors. This result was generally expected. What is unusual about both this and the previous question is that both of these questions tapped into the core process of involvement and both answers were generally high. This conflicts with the previous low statements from the managers concerning involvement with the R & M process. It appears that if the question had the title R & M in it, then the response was generally low. If the question did not reference the program, then the response was higher. What the managers may have failed to realize is that the critical and common maintenance actions that they *do* get involved with, *do* include actions

concerning R & M, and that they indeed *have been* getting involved in the R & M 2000 program without fully being aware of it.

Additional questions attempted to draw out further feelings of the maintenance managers concerning the extent that they felt the program was their responsibility or someone else's. These again should give some insight as to the level of institutionalization at the implementation stage of the program.

Questions 22, 24, & 27: I do my job differently now as opposed to before the R & M 2000 Program was instituted; R & M is the responsibility of someone else; R & M is the primary responsibility of AF Systems or Logistics Command. The primary emphasis of these three questions was to determine if the maintenance managers felt that the R & M 2000 program implementation was part of their responsibility or that of someone else. Based on some of the previous responses dealing with involvement, it was expected that the responses would be on the low side of the scale.

Do Job Differently After R & M 2000 Program (Question 22).

Generally, all of the responses to this question were ranged on the low side of the scale as predicted. The medians ranged from 2 for the AGS Maintenance Supervisors to 4 for the CRS Maintenance Supervisors. The medians for the DCMs and EMS Maintenance Supervisors filled in the range with values of 3 and 3.5, respectively. The modes were low for the DCMs and AGS Maintenance Supervisors; the DCMs had a mode of 2, and the AGS Maintenance Supervisors had a modal value of 1. Both of the other categories showed modes of 4, but both also had a considerable number of responses below that value. In both cases, no responses fell in the

moderately or strongly agree scale values. The *H* test was conducted to show statistically that the CRS and EMS Maintenance Supervisors' distributions were indeed not the same as the DCMs and AGS Maintenance Supervisors. However, all of the response categories had relatively strong secondary modes, showing strong responses at the 1 and 2 scale values as well as the 4 scale value. As such, the statistical tests could not verify at the 99% and 95% levels that the distributions were indeed different. Figure D.11 displays the survey response histograms for question 22.

For the most part, the distributions of responses followed the expectations for this question. The low responses indicated that the maintenance managers were not doing their jobs differently since the R & M 2000 program came into being. Their management efforts have remained the same. One must be careful not to say that they have not institutionalized the implementation of the program. The responses to this question simply indicated that they don't do their jobs necessarily any differently because of the new program. It is possible that the way that they had accomplished their jobs before the program already incorporated all of the goals and precepts of the program. Further research should be conducted in this area to possibly find out if the way the maintenance managers in the field were doing their jobs before the R & M 2000 program accomplished all of the required actions the new program set out to meet.

R & M Is The Responsibility of Someone Else (Question 24). This question was designed to see the emphasis that the maintenance managers placed on reliability and maintainability. It was anticipated that the

answers to this question would be that they at least moderately disagreed, with a significant number of managers strongly disagreeing.

Below, Figure 4.11 denotes the strong low response rates for all of the maintenance managers. The DCMs had a median of 1 with a mode of 1. The AGS and CRS Maintenance Supervisors both had medians of 2 with modes of 1. The EMS Maintenance Supervisors only differed slightly with both a median and mode of 2. Because of the strong consensus, this question was not subjected to the  $H$  test.

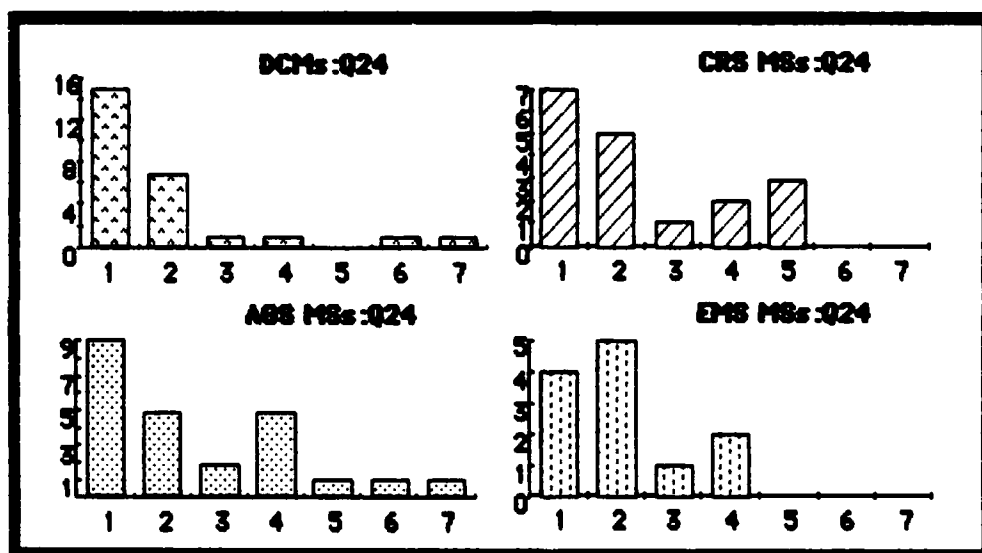


Figure 4.11. Section 1, Question 24 Survey Response Histograms

The results of this question were not unexpected. It was strongly predicted that even though other results may have shown that the R & M program does not appear to be institutionalized to a great extent in the implementation stage, the maintenance managers would not shirk their responsibility to make sure that R & M was part of their weapon system. The only question becomes whether they knew how to accomplish this task.

Again, additional research should be carried out to determine why the managers felt so strongly about the responsibility of the program.

R & M Is The Primary Responsibility of AF Systems or Logistics Command (Question 27). Question 24 inquired whether the program was simply the responsibility of someone else. This question puts a specific name to *someone else*. It is generally agreed that a lot of the specifics in the R & M regulations applied to the AF Systems or Logistics Command, inasmuch as they are responsible for designing and acquiring new systems for the field. Thus, the responses for this question were expected to be higher on the scale than the previous question, even possibly ranging to the slightly agree value of the scale.

The prediction for this question held true. The responses were more spread out than the previous question, even in some cases up to the strongly agree value. The medians only showed a minor amount of variation, ranging from 3 for the DCMs to 4.5 for the AGS Maintenance Supervisors. The other two categories both showed medians of 4. Despite this apparent agreement, the modes varied greatly. The DCMs and EMS Maintenance Supervisors displayed modes of 1, with the AGS Maintenance Supervisors only slightly higher with a mode of 2. The CRS Maintenance Supervisors answered with a mode of 5. In all cases, as seen in Figure D.14, the spread of responses for each category was great. Second and third highest responses were just one or two respondents behind. The  $H$  test was required to verify the disagreements in attitudes shown by the modal distributions. With the relatively low number of responses in each manager category at any one scale value, the  $H$  test results were not strong enough

to prove that at least two of the four distributions were different. At both confidence levels, the statistical test concluded the response distributions were the same.

The results of this question were generally inconclusive, but a trend did appear to show slightly. A minor shift to the higher part of the scale was seen in the CRS Maintenance Supervisors. It is usually accepted that these Maintenance Supervisors get more involved with the Systems and Logistics Command in their daily operations. The CRS squadrons deal with many intricate, reliability sensitive electronic parts, usually including the internal workings of many Line Replaceable Units. As a result, they may slightly feel that R & M is more AFSC and AFLC's responsibility, such that the CRS squadrons (and ultimately the rest of the flightline) would be provided with better parts and equipment in the long run. Any conclusions beyond this would be outside the bounds of the initial question.

Questions 17, 23, 25, 26, & 28: I frequently brief my personnel on the importance of the R & M policies; I encourage my subordinates to practice R & M policies; Motivation of my troops is essential in institutionalizing the R & M 2000 Program; My inputs into the R & M process actually affect decisions at other levels; My effort in promoting R & M is greater than that of my coworkers. The designs of these five core process questions were to detect if the maintenance managers felt strong enough about the program to implement it amongst their subordinates and peers. The responses to these questions were anticipated to be on the high side of the scale, but staying only in the slightly agree area.

### Frequently Briefing Personnel on Policy Importance (Question 17).

The results of this question were puzzling with respect to the Maintenance Supervisor categories. The DCMs responded with a median value of 3.5 and a mode of 6. This was significantly different than the other maintenance manager categories. The AGS Maintenance Supervisors exhibited a median of 1; the CRS Maintenance Supervisors, a median of 3; and the EMS Maintenance Supervisors, a median of 2. All of the Maintenance Supervisors showed modes of 1. Figure D.9 shows the modal results of this question. Because of the DCM nonconsensus, the  $H$  test was necessary. As the DCMs were the only category to significantly disagree, the  $H$  test could not reject the null hypothesis at the 99% confidence level. With 99% confidence, the statistical tests revealed that at least two of the four distributions were not different. However, at the 95% confidence level, the results were not the same. At the 95% level, the observed  $H$  value was above the test statistic and the null hypothesis could be rejected. Possibly the EMS Maintenance Supervisors' spread of responses, with their corresponding low response rate per scale value, contributed to the differences in the  $H$  test results.

From the responses of this question, it appears as though the DCMs brief their personnel on the importance of the program policies, but the Maintenance Supervisors do not carry on the task. It must be noted that the DCMs did not show complete consensus as the distribution of their responses was widely scattered across the entire scale. In addition, the modal response of 6 was not strong; the second highest values of 1 and 2 were just one respondent behind. Overall, the trend of this question

showed that the policies of the program were being briefed frequently to only a very little extent.

Encouraging Subordinates to Practice R & M Policies (Question

23). While the maintenance managers did not appear to frequently *brief* their subordinates on the program precepts, they could still strongly *encourage* the practices of the program precepts through other means.

This question was asked to detect just that.

Generally, the responses to this question support the hypothesis that briefing is not the only way to implement a program. The median for the DCMs was 6, and they showed the same modal response value. The AGS Maintenance Supervisors responded with a median of 4.5 and a mode of 5. The CRS Maintenance responded similarly with a median of 5 and dual modes of 4 and 5. Finally, the EMS Maintenance Supervisors had a median of 5, but their mode was much higher with a 7. Figure D.12 displays the shapes of the modal response distributions for this question. As the mode for the EMS Maintenance Supervisors was slightly higher than the others, the *H* test was required to determine the statistical similarity or dissimilarity between the distributions. The *H* test results from Table 4.3 strongly indicated that the response distributions were indeed different. At both confidence levels of 95% and 99%, the null hypothesis was rejected.

Overall, the responses to this question verify that the maintenance managers do encourage the support and implementation of the R & M 2000 program. The extent does vary from manager to manager, but a majority of all of the opinions were on the high side of the scale, indicating a general agreement with the initial statement.



Institutionalization Through Motivation of Troops (Question 25). This question was developed to further determine the core process of promoting the implementation of the R & M 2000 program. This is the first question where the term institutionalization was used. It was placed in this part of the survey to find out if the maintenance managers felt that if they motivated their troops, then the troops would also institutionalize the program. It should be noted that this question did not intend to determine if the troops knew what the program was or was not, it merely intended to see if the maintenance managers felt that they could institutionalize something in those troops through motivation.

The responses to this question were generally as expected. The DCMs and AGS Maintenance Supervisors tallied medians of 6 with relatively strong modes of 7. The CRS Maintenance Supervisors were indecisive with a median of 5 and tri-modal values of 4, 5, and 6. The value of 7 was also only 1 respondent different for the CRS category. The EMS Maintenance Supervisors showed a median of 4 with the same mode. The modal distributions are shown in Figure D.13 in Appendix D. As the modal values varied by two, the *H* test was required per this research methodology. However, because of the relative indecisiveness of the CRS Maintenance Supervisors, the *H* test could not conclude that the distributions were different. At confidence levels of 99% and 95%, the null hypothesis was not rejected. Any confidence levels lower than 95% would give unacceptable risks of the conclusions being wrong.

Overall, it can be stated that the maintenance managers felt that motivation of their troops *was* essential in institutionalizing the R & M 2000

program. This was seen by the fact that nearly 61% of the respondents slightly to strongly agreed with the initial statement, and 78.6% of the respondents answered from the scale value of 4 and above.

Inputs Affecting Decisions at Other Levels (Question 26). Tying again back to the theme of involvement, this question was designed to determine whether or not the maintenance manager felt his inputs into the R & M process were actually affecting overall R & M decisions.

The maintenance manager categories all differed in their responses to this question. The median for the DCMs was 5, and for the AGS Maintenance Supervisors was 4. The median for the CRS and EMS Maintenance Supervisors was 4.5. The modes were 5, 4, and two 6s for the DCMs, AGS Maintenance Supervisors, and CRS and EMS Maintenance Supervisors, respectively. The modal distributions are charted in Figure D.13. The DCMs and EMS Maintenance Supervisors appear to be similar, but because the other two manager categories vary by two scale values, the *H* test was accomplished. Despite the appearance of disagreement, this could not be concluded statistically. The low response rates for all of the DCMs and EMS Maintenance Supervisors' scale values contributed to the inability of the *H* test to reject the null hypothesis at either confidence level.

As the DCMs and EMS Maintenance Supervisors did not include strong modal responses, the only conclusion that could be made from this question was to look at the side of the scale which included the majority of answers. The answers tended toward the high side of the scale with over 48% of the responses falling into the 5 to 7 scale values. As such, most of the

maintenance managers felt that their inputs did have some type of effect on R & M decisions at other levels.

Promoting R & M (Question 28). The final question in the first section of the survey concerning the implementation of the R & M 2000 program was asked to find whether the maintenance managers felt they were promoting the new program more than that of their coworkers. Answers were expected to range with the neither disagree nor agree scale value. The reason for this expectation was that it was felt that most managers would not find that their coworkers were working harder on a higher headquarters directed program.

The results were just as foreseen. The  $H$  test was not required as consensus was gained by all maintenance managers with both the median and the modal values. Question 28's actual  $H$  test results, shown in Table 4.3, verify the fact that the  $H$  test was not necessary. All of the modes of 4 were strong with only a few spread out secondary responses. On the following page, Figure 4.12 displays the strong modal response histograms.

The anticipated responses for this question indicated that whether the program was felt to be important or not, the maintenance managers were not going to implicate that another manager was not doing his part in promoting the program. It was felt that no other answer could have been drawn out even by wording the question differently. In every organization, there is always someone who is doing more and there is always someone who is doing less.

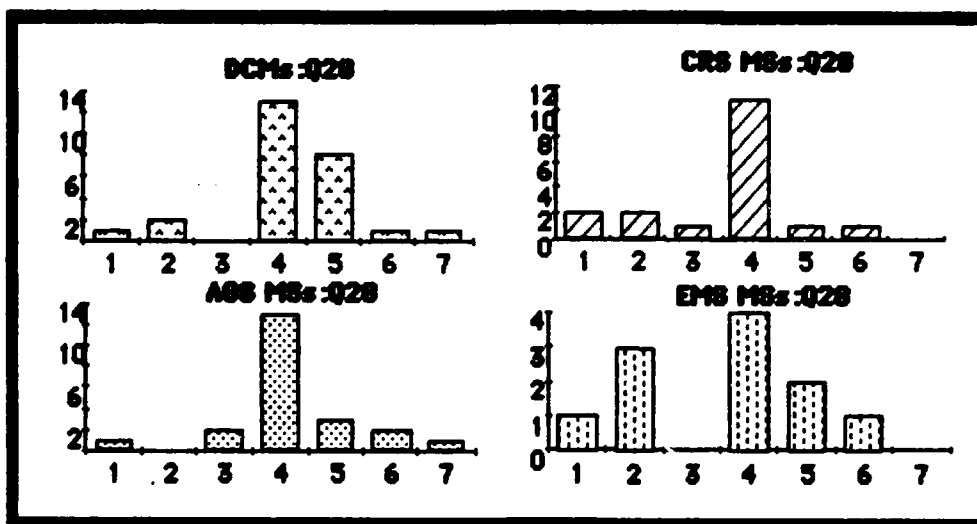


Figure 4.12. Section 1, Question 28 Survey Response Histograms

#### Overview of Section 1: Implementation of R & M 2000 Program.

The previous twenty eight questions were all designed to draw out opinions and attitudes of TAC maintenance managers concerning the degree or extent they had implemented the R & M 2000 program. In general, it appears as though the maintenance managers were knowledgeable of the goals of the R & M 2000 program. But, they basically felt that they had little control over improving the goals in their units. Therefore, overall, the managers did not strongly participate in the implementation of the R & M 2000 program at the TAC level. The statistical  $H$  tests were used to detect differences between maintenance manager response distributions. The tests revealed that, for the most part, conclusions could be applied across all maintenance manager categories. Stepping to the next investigative question, the following section of the survey was analyzed.

Program Education and Training Survey Responses. [Section 2] This second section of the survey instrument was designed to draw out

information concerning the education and training levels of the maintenance manager respondents. This was intended to supplement the implementation information evaluated from the first survey section. The demographics of the survey were first looked at to analyze the results of the last question in that section. Then the median/mode comparison table was again scanned for consensus responses. Only questions 1, 2, 3, 17, and 21 of the twenty one questions in this section obtained consensus. As previously mentioned, the consensus of these questions did not complete their evaluation, as they might be tied together and vital to the responses from another question. Questions 1 through 16 used the agree/disagree scale and questions 17 through 21 used the extent scale. Figure 4.13 shows the scales for this survey section.

1. To a very little extent	5. To a fairly large extent
2. To a little extent	6. To a great extent
3. To a moderate extent	7. To a very great extent
4. Neither moderate nor great extent	
1. Strongly disagree	5. Slightly agree
2. Moderately disagree	6. Moderately agree
3. Slightly disagree	7. Strongly agree
4. Neither disagree nor agree	

Figure 4.13. Survey Response Scales (Section 2)

The purpose of this section was not only to place the responses to the questions into Levy's culture change level, it also was used to detect the

level of importance the maintenance managers placed on education and training for the R & M 2000 program.

Statistical Tests. The Kruskal-Wallis  $H$  test was also conducted for all of the questions in this section of the survey. To reiterate, the confidence level associated with the conclusion of the statistical tests is indicated by the "ã" value. This section's  $H$  test results are shown in Table 4.4 on the following page with both the 95% and 99% confidence levels.

Demographic Question: Have you been formally trained on the concepts of R & M 2000? The answers available to the maintenance manager respondents were yes or no. If the answer was no, then four secondary categories were provided to determine where the formal training was conducted. First, 79.3% of the maintenance managers responded "no" to this question. Of the 20.7% that responded "yes", the following breakdown is provided:

- (1) AFIT PCE course ----- 0 out of 16 (0%);
- (2) Local military course ----- 3 out of 16 (18.75%);
- (3) Academic University course ----- 0 out of 16 (0%);
- (4) Other ----- 13 out of 16 (81.25%)

(including mostly AFIT Graduates and prior AFLC jobs).

This percentage analysis does not provide a total picture of the education level of the respondents. Many of the managers received training concerning many of the program concepts many years ago. There may be correlations between some possible prior training, as some of the same concepts have been taught in the Air Force for many years. Further questions in this section of the survey were constructed to determine the

Table 4.4. Kruskal-Wallis H Test Results (Survey Section 2)

H<sub>0</sub>: The 4 probability distributions are identical

H<sub>a</sub>: At least 2 of 4 distributions differ in location

Rejection Region: ( $\alpha = .05$ )  $H > 7.81473$

Rejection Region: ( $\alpha = .01$ )  $H > 11.3449$

[3 degrees of freedom]

Question #	Observed H	$\alpha=.05$	$\alpha=.01$
1	3.7698	SAME	SAME
2	4.6498	SAME	SAME
3	10.4002	DIFFERENT	SAME
4	5.4812	SAME	SAME
5	3.6563	SAME	SAME
6	4.5486	SAME	SAME
7	9.4681	DIFFERENT	SAME
8	5.3612	SAME	SAME
9	5.5155	SAME	SAME
10	9.2683	DIFFERENT	SAME
11	12.5684	DIFFERENT	DIFFERENT
12	11.5364	DIFFERENT	DIFFERENT
13	10.7239	DIFFERENT	SAME
14	5.2302	SAME	SAME
15	11.4409	DIFFERENT	DIFFERENT
16	4.4031	SAME	SAME
17	3.6022	SAME	SAME
18	3.9081	SAME	SAME
19	7.7141	SAME	SAME
20	16.9206	DIFFERENT	DIFFERENT
21	6.7656	SAME	SAME

extent that maintenance managers in TAC today may be aware of the precepts of the R & M 2000 program despite the fact that they may or may not have received formal specific R & M training. The questions were also designed to determine an overall attitude amongst TAC maintenance managers concerning training as it is related to any new program.

Question 1: Training is essential in establishing any program during its initial phases. The purpose of this question was to get an initial feeling of the level of importance that the TAC maintenance managers placed on training programs in general. The responses were anticipated to be on the high side of the scale with values from moderately to strongly agree.

The results of this question met and exceeded expectations. The medians and modes were both very strong for all maintenance manager categories with values of 7. Figure D.15 shows the shapes of the modal distributions. Because of their complete consensus, the statistical  $H$  test was not needed.

Interpretations of these responses were easy. One could strongly conclude that all TAC maintenance managers felt that training is essential. It remained to be further seen from additional survey questions whether that training was actually conducted for this program. Initially, as seen from the demographic answers, only a select few had received any *formal* R & M training.

Question 2: It is necessary to have a formal course established to teach R & M concepts. Training can be conducted in a variety of ways. The design of this question was to determine the level of agreement that the TAC managers felt whether it was necessary to conduct *formal* training



in order to institutionalize the program. The results of this question were expected to be on the high side of the scale, but not as strong as the previous question's responses.

The outcomes of the responses were just as projected. The DCMs responded with a median and mode of 5; The AGS and CRS Maintenance Supervisors both tallied modes of 6; the AGS Maintenance Supervisors showed a median of 6, whereas the CRS Maintenance Supervisors showed a median of 5. The EMS Maintenance Supervisors mimicked the DCMs with 5s for both the median and mode. As no responses varied by more than one scale value, consensus was considered to be attained and the  $H$  test was not required. Table 4.4 verified the applicability of the methodology to this section of the survey. As shown in the table, the observed  $H$  test values did not allow for the rejection of the null hypothesis at either confidence level. Figure 4.14 below shows the strong modal responses.

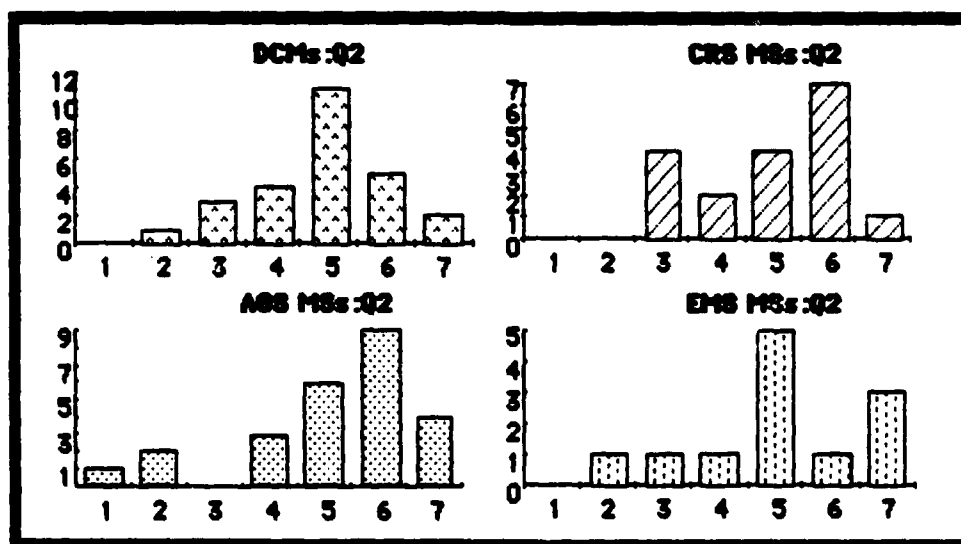


Figure 4.14. Section 2, Question 2 Survey Response Histograms

Despite the fact that there are many different ways of training, the TAC managers concluded that formal training was required to teach the R & M concepts. The reasons for this conclusion are numerous and varied, the details of which are not important for this research effort. It was simply sufficient to determine that the TAC managers felt that a formal training course *was required*. Why a substantial majority of them never received any formal training should be the topic of continued research.

Question 3: I have been educated in the ways of R & M through my own daily experiences. Since the majority of managers did not receive any formal training, this question was asked to find out if they learned the precepts of the program through their own experiences on a daily basis. Most maintenance managers were expected to respond on the high side of the scale with possible modes of 5 or 6.

Again, the results were just as expected. The DCMs were the only category that did not show medians and modes of 5; they displayed a median and mode of 6. All of the modes were strong, particularly those of the Maintenance Supervisors. With the responses showing agreement, no *H* test was necessary. However, as Table 4.4 shows, at the confidence level of 95%, the null hypothesis was rejected and at least two of the four distributions could be considered to be different. Despite this apparent conflict, at the 99% level, insufficient information was available to statistically reject the null hypothesis and the distributions were indeed considered the same. Figure D.16 displays the survey response histograms.

The analysis of this question led to the finding that a majority of the maintenance managers felt that they were self trained. Their daily

activities exposed them to the precepts of the R & M 2000 program, and as such, they became trained enough to institutionalize the program. Any other conclusions beyond this would be purely speculative.

Questions 4 & 13: Through my own experiences, I have sufficiently trained myself concerning R & M 2000 Program management; My experience has been gained primarily by "learning as I go". These two additional questions in this survey section were designed to extract more information concerning the apparently vicarious process of R & M education and training. The first question was designed to detect if the maintenance managers felt they were *sufficiently* trained. The second question was placed later in the survey to validate question 3; it was designed to ask a similarly worded question to that of question 3.

Sufficient Training (Question 4). The results of this survey question did not follow that of the previous question. The DCMs, AGS and CRS Maintenance Supervisors all showed a median of 3. The EMS Maintenance Supervisors responded with a median of 2. In the cases of the DCMs and AGS Maintenance Supervisors, the medians did not show a true picture of the distribution of responses. The DCMs mode was a weak value of 2 with two secondary modes only one response behind and two tertiary modes just two responses behind. The values ranged on both the low and high side of the scale. The AGS Maintenance Supervisors also displayed a significant degree of nonconsensus. Their tri-modal responses carried values of 1, 2, and 3. Alternately, the CRS and EMS Maintenance Supervisors showed relatively strong modal values of 3 and 2, respectively. Figure D.16 charts the modal response frequencies for this question. The *H*

test was conducted to statistically prove the distributions were not the same. However, because of the weak modal values of the DCMs and AGS Maintenance Supervisors, the  $H$  test could not conclude that the distributions were different at least at the 95% confidence level.

Despite the wide variation of responses, a general conclusion can still be made. Nearly 60% of the responses fell on the low side of the scale. This indicates that for the most part, the maintenance managers were in disagreement with the initial survey statement. Only the extent of disagreement could not receive consensus. Thus, a majority of TAC maintenance managers felt that they *had not* sufficiently trained themselves through the vicarious process.

"Learning As I Go" Education Process (Question 13). As previously stated, the purpose of this question was to validate the responses that the maintenance managers felt that they learned the program precepts on their own.

As seen in Figure 4.15 on the following page, the distribution of responses tended toward the high side of the scale. The DCMs and EMS Maintenance Supervisors showed medians of 6, with modes of 6 and 7, respectively. Both the AGS and CRS Maintenance Supervisors had medians of 5. They also both showed modes of 5, as well as the AGS Maintenance Supervisors showing a dual mode of 6. Generally, there was consensus with the responses, but because the mode of the EMS Maintenance Supervisors was two values different than the other categories, the  $H$  test was required. As with previous questions, because of the disagreement of only one manager category, the  $H$  test could not strongly conclude the distributions

were different. At the 95% confidence level, the null hypothesis could be rejected and the distributions could be considered different. Yet, at the 99% confidence level, the null hypothesis could not be rejected and the distributions were considered the same. Again, at the higher confidence level, low response rates for the EMS Maintenance Supervisors could cause the test to not prove that at least two of the four distributions differed.

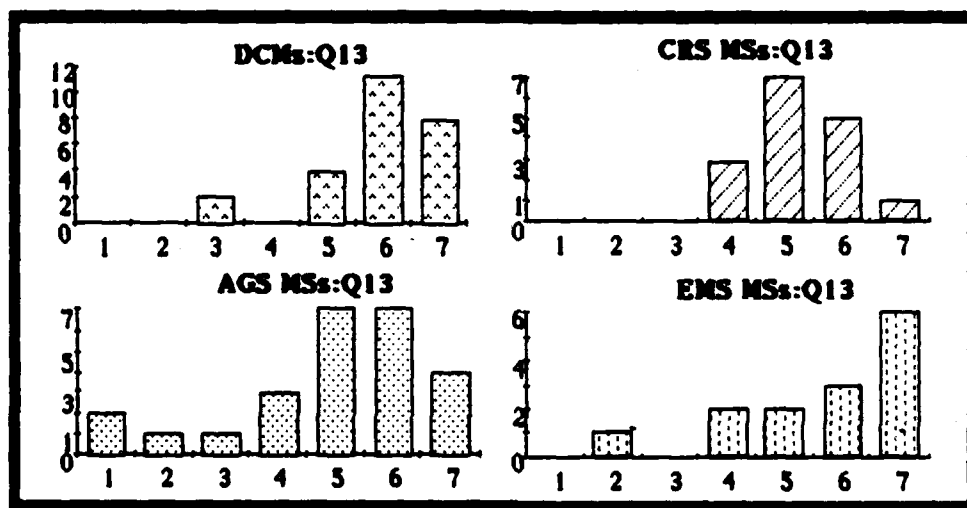


Figure 4.15. Section 2, Question 13 Survey Response Histograms

This question did what it was intended to do. Overall, it verified that the maintenance managers felt that they did learn the program and gain experience in the R & M concepts on their own. This does not conflict with question 4 because this question did not mention whether the maintenance managers felt that their "learning as they go" was necessarily sufficient.

Questions 5, 6, 7, 8, and 9: My subordinates understand what reliability means; My subordinates understand what maintainability means; The next higher level of management is interested in R & M practices;

AFSC understands what R & M means; AFLC understands what R & M means. The primary emphasis of these five survey questions was to determine the extent that the maintenance managers felt others understood the R & M 2000 program. The basic hypothesis was that if the others did not understand what the program entailed, then any R & M efforts by the TAC maintenance managers would probably be in vain.

Subordinates Understanding Of Reliability (Question 5). This question nearly gained consensus. The majority of the answers were on the high side of the scale, but the modes of the AGS and EMS Maintenance Supervisors varying by two scale values, from 5 to 7, caused a requirement for the  $H$  test. The other two maintenance manager categories showed modes of 6. The medians did not vary greatly either. The DCMs and CRS Maintenance Supervisors tallied 6s, whereas the AGS and EMS Maintenance Supervisors showed medians of 5 and 5.5, respectively. Because the variations from consensus were small, the  $H$  test could not conclude the distributions were different at either confidence level tested in Table 4.4. The survey response histograms are exhibited in Appendix D (Figure D.17).

Generally, the results of this question indicated that the TAC maintenance managers moderately agreed that their subordinates understood what reliability meant. This conclusion might possibly imply that training and education of the concepts of reliability have already taken place in the managers' subordinates.

Subordinates Understanding Of Maintainability (Question 6). It was expected that the responses to this question would be similar to the previous question. If they were, then the same conclusion could be stated.

Figure D.17 for this question shows that the distributions of responses were nearly the same as the previous question. The DCMs and AGS Maintenance Supervisors responses resulted in medians of 6. The CRS and EMS Maintenance Supervisors followed with medians of 5 and 5.5. All of the modes also fell on the high side of the scale. The DCMs responded with a mode of 6, whereas the AGS Maintenance Supervisors showed a dual mode of 5 and 7. Both of the CRS and EMS Maintenance Supervisors also almost responded with dual modes. The CRS Maintenance Supervisors actually answered with a mode of 5 with the value of 7 being only one respondent behind. The EMS Maintenance Supervisors responded just the opposite of the CRS respondents. Their mode was 7 with the value of 5 being just one respondent behind. The  $H$  test was required because of the range of the modes being from 5 to 7. The statistical results, however, did not show that the distributions were different. The observed  $H$  value in Table 4.4 shows that at both the 99% and 95% confidence levels, the distributions were evaluated as being identical.

Overall, the results of this question were the same as the previous question. With 88.1% of the respondents falling in the scale range from 5 to 7, it could be concluded that the maintenance managers generally agreed that their subordinates understood what maintainability meant.

Higher Level Management Interest (Question 7). Question 7 was aimed at finding the extent that the TAC managers felt that they were being supported by higher supervision. In the case of the DCMs, this was typically the Wing Commander. With the Maintenance Supervisors, this level could have been the Squadron Commander or the DCM.

The results from this question were interesting. The DCMs showed an odd distribution of responses, with strong high as well as low responses. The median of the DCMs fell on the scale value of 4 with dual modes of 6 and 7. As seen by Figure 4.16 on the next page, this does not account for the numerous low responses. The answers from the Maintenance Supervisors tended toward the higher side of the scale. The AGS Maintenance Supervisors had a median and mode of 5. The CRS Maintenance Supervisors had a median of 6 with tri-modal values of 5, 6, and 7. The EMS Maintenance Supervisors showed a strong median and mode of 7. As per this research methodology, the  $H$  test was required to statistically conclude the distributions were different. At the 95% confidence level, the  $H$  test did indeed conclude that the distributions were different. Still further, at the 99% confidence level, insufficient evidence was available to reject the null hypothesis. Therefore, at the 99% confidence level, the response distributions were looked at as being the same. The low response rates per scale value of the DCMs and the tri-modal values of the CRS Maintenance Supervisors may have contributed to this lack of consistent  $H$  results at the two tested confidence levels.

It is important to note that all of the responses of the Maintenance Supervisors that tended toward the high side of the scale, referred to other individuals also *in* the maintenance complex. The DCMs responses were commonly referring to managers outside the maintenance complex and they had some disagreement as to the extent that those higher level managers might have been interested in the R & M practices. Why some of the DCMs felt that the next level higher of management might not have been interested in the R & M 2000 practices should be investigated further.



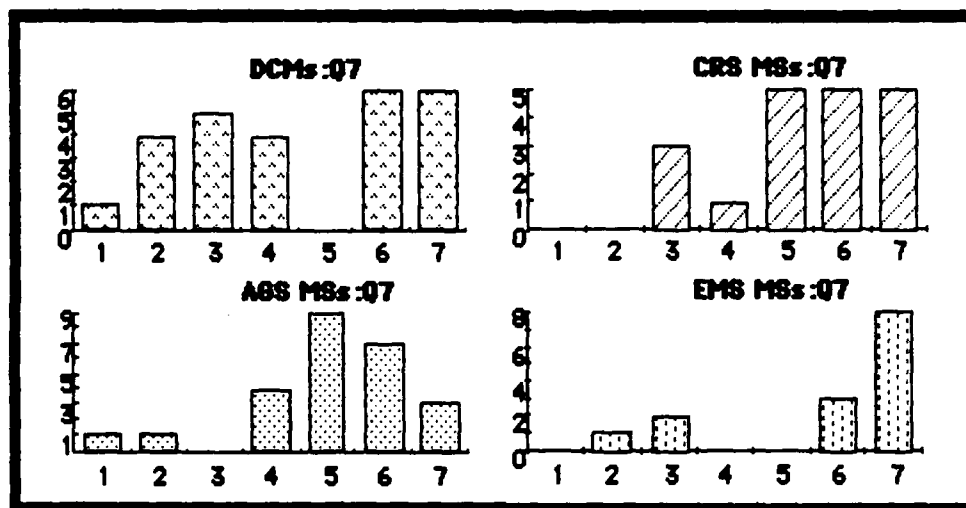


Figure 4.16. Section 2, Question 7 Survey Response Histograms

AFSC's Understanding of R & M (Question 8). As it is generally known that AFSC is involved with the acquisition of weapon systems, it was assumed that the TAC maintenance managers would agree that the AFSC personnel would understand the program at least moderately.

The results of this question did not turn out as expected. The DCMs and EMS Maintenance Supervisors responded with strong medians and modes of 4. The AGS Maintenance Supervisors had a median of 6 with a weak mode of the same value. The CRS Maintenance Supervisors showed a median of 5 with a mode of 4. Figure D.18 charts the response frequencies for this question. The variation of the medians and modes by two scale values gave reason to conduct the statistical  $H$  test. Despite the median and modal differences, the  $H$  test could not provide conclusive evidence that the distributions were different. At just slightly lower of a confidence level

than 95%, the null hypothesis could have been rejected. This, however, would lead to an unacceptable risk of an error in the final conclusion.

With the exception of the AGS Maintenance Supervisors, the remaining manager categories neither agreed nor disagreed that AFSC understood the meaning of R & M. Further research in this area might uncover reasons for this noncommittal attitude towards AFSC.

AFLC's Understanding of R & M (Question 9). As it was known that AFSC is involved in weapon system acquisition, so is it known that AFLC generally supports that acquisition by providing logistical support throughout the life of the asset. Inasmuch as both AFSC and AFLC support the 'using' commands, the expectations for this question were the same as the previous question.

Again, the expectations were not entirely met. The DCMs' responses resulted in a median value of 5. They also incurred dual modes of 4 and 7. As seen from Figure D.19, most of the responses fell on the high side of the scale. The Maintenance Supervisors' distributions of responses all varied greatly. The AGS Maintenance Supervisors showed a median value of 6 with the same mode. The CRS Maintenance Supervisors had a median of 5 with a mode of 6. These managers also had a considerable number of respondents answer with the value of 4. The EMS Maintenance Supervisors had a median of 4 with a strong mode of the same value. The  $H$  test was necessary to conclude that the statistical distributions were not the same between all of the maintenance manager categories. However, at the 95% confidence level, the  $H$  test could not conclude that the distributions were different. As shown from Table 4.4, the observed  $H$  value for this question

below the test statistic for both confidence levels tested. This signified the inability to reject the null hypothesis stating the four distributions were identical. The four response distributions were therefore statistically considered the same.

Nevertheless, the overall results of this question were less conclusive than the previous question. The tendency toward the value of 4, to neither agree nor disagree, was the only evident trend. Again, further research should be conducted to determine the similar reasons for the noncommittal attitudes concerning the capabilities of AFSC and AFLC to understand the meanings of R & M.

Questions 10, 11, & 12: My organization has instituted sufficient training programs for R & M; R & M education and training in my unit primarily emphasizes the weapon system itself; My R & M education and training program addresses support equipment and supply items as well as the aircraft in my unit. The primary emphasis of these questions was to uncover information concerning the education and training programs within each of the maintenance managers units. The responses were generally expected to range on the low side of the scales for the first three questions and then on the high side of the scales for each of the last two questions.

#### Institution of Sufficient Training Programs (Question 10).

Responses to this question were anticipated to be on the low side of the scale. From the analyses of previous questions, formal training did not appear to be conducted for TAC managers. As such, the managers should not feel that there were sufficient training programs available.

Responses did tend toward the lower side of the scale for this question. The DCMs and CRS Maintenance Supervisors both had medians of 3, with modes of the same value. Figure D.19, included in Appendix D, shows that the DCMs modal value was not as strong as the CRS Maintenance Supervisors. Both the AGS and EMS Maintenance Supervisors showed medians with the scale value of 2. Where the AGS Maintenance Supervisors had a strong mode of 1, the EMS Maintenance Supervisors showed a dual mode of 1 and 2. The *H* test was required because of the range of modal values amongst the maintenance manager categories. As seen from Table 4.4, at the 95% confidence level, the distributions were viewed as being different. However, at the 99% confidence level, there was not enough information to sufficiently reject the null hypothesis. With the tendency of virtually all of the responses staying on the low side of the scale, the 99% confidence level could not detect a significant rank sum difference to conclude that at least two of the four distributions differed in location.

Despite the slight disagreement with the extent on the low side of the scale, this was the tendency for responses to this question. Only 7.1% of the managers responded on the high side of the scale. Therefore, a general conclusion was made that the TAC managers felt that their units did not have sufficient programs instituted for R & M teachings.

Training Emphasis on the Weapon System (Question 11). The purpose of question 11 was to determine the extent that the training that was being conducted on just the weapon system itself, not including support functions, equipment, and other assets. The answers were anticipated to be on the lower side of the scale because, in general, most

broad level training programs do not include a large amount of emphasis on topics other than the weapon system itself.

The DCMs showed a clumping of responses with a median of 5 and a mode of the same value. The AGS and CRS Maintenance Supervisors both had medians of 4 and their modal distributions were slightly similar. The AGS Maintenance Supervisors had a mode of 4 with a significant number of responses also at the scale value of 1. The CRS Maintenance Supervisors also closely resembled the DCMs with virtually all of the responses clumped around the dual modal values of 4 and 5. The EMS Maintenance Supervisors varied slightly as spread out responses became a factor with their answers. Their median was 4, as was their mode. However, they also showed a second mode of 1. The responses with the values of 5 and 6 were only one respondent behind. Even though it was considered weak, the EMS Maintenance Supervisors secondary mode of 1 gave rise to the requirement for the  $H$  test. The observed  $H$  value for this question, shown in Table 4.4, was greater than both the 95% and the 99% confidence level test statistics. This allowed the rejection of the null hypothesis, indicating that at least two of the four distributions were different. Figure D.20 displays this questions modal charts.

As with a few previous questions, the tendency of the responses to center on the value of 4 made the results basically inconclusive. The percentage of responses with the value of 4 was a significant 29.7%. Overall, the maintenance managers neither agreed nor disagreed that the training programs in their units emphasized just the weapon system itself. Additionally, the statistical differences of at least two of the four distributions warranted further research to determine why, in addition to

the tendency toward the scale value of 4, the managers disagreed with all of the other responses to this question.

#### Training Emphasis on Support Equipment and Supply Items

(Question 12). Since the managers neither agreed nor disagreed about the previous question, it was hypothesized that the answers would be nearly the same for this question. This question was designed to possibly detect the extent that the training programs might have included information concerning the support emphasis of the R & M 2000 program.

As displayed in Figure D.20, the DCMs responded with a median value of 5 and a strong mode of 6. A large number of respondents also felt the scale value of 4 was an appropriate answer. The AGS and CRS Maintenance Supervisors did not commit to one side of the scale or the other, as both showed medians and modes of 4. The EMS Maintenance Supervisors displayed a shift to the low side with a median of 2 and a mode of the same value. This shift required the statistical  $H$  test to be accomplished. The  $H$  test verified that with the wide spread of responses across the scale, it could be statistically shown that at least two of the four distributions differed. At the 95%, as well as the 99%, confidence level, the null hypothesis was rejected.

The reason for the EMS Maintenance Supervisors shift to the low side of the scale is unknown. Also unknown is the reason for the DCMs slight shift to the right of the other maintenance manager categories. Further research concerning the extent of TAC units' training programs including support equipment and supply items information is warranted.

Question 14: R & M is more important in newer weapon systems.

Many of the weapon systems in TAC are not entirely new. The A-7 and F-111 aircraft were built in the late 1960s. As such, this question was simply designed to determine the extent that TAC maintenance managers felt that the R & M 2000 program was initiated just for new weapon systems, and thus possibly did not entirely apply to them. The responses to this question were anticipated to range on the low side of the scale, because it was felt that most managers should realize that R & M applies to all systems, new or old.

The responses to this question were puzzling. They did not follow any trend, other than general nonconsensus. On the following page, Figure 4.17 shows the uncommon modal frequency distributions for this question. Despite having an apparently strong mode of 7, the DCMs showed a median of 3.5, a significant number of responses answering at the 1 scale value. The AGS Maintenance Supervisors responded with a median value of 4 with a moderately weak mode of 1. Again, a significant number of respondents answered on the opposite side of the scale as the mode. The EMS Maintenance Supervisors also showed similarly inconsistent responses. Their median value was 4.5 with a weak mode of 6. The second highest value of 1 was just one response behind. Finally, the CRS Maintenance Supervisors displayed the most consistency of any responses in the other categories. Their median was 5, with dual modal values of 5 and 7. The *H* test was definitely required to determine statistically that the distributions were not the same. Despite the apparent differences between the medians and modes, the statistical test could not conclude that the distributions were

different. Both of the confidence levels indicated that the response probability distributions were the same. The low response rates at any one scale value for any manager category possibly led to the inability to consider the distributions as different.

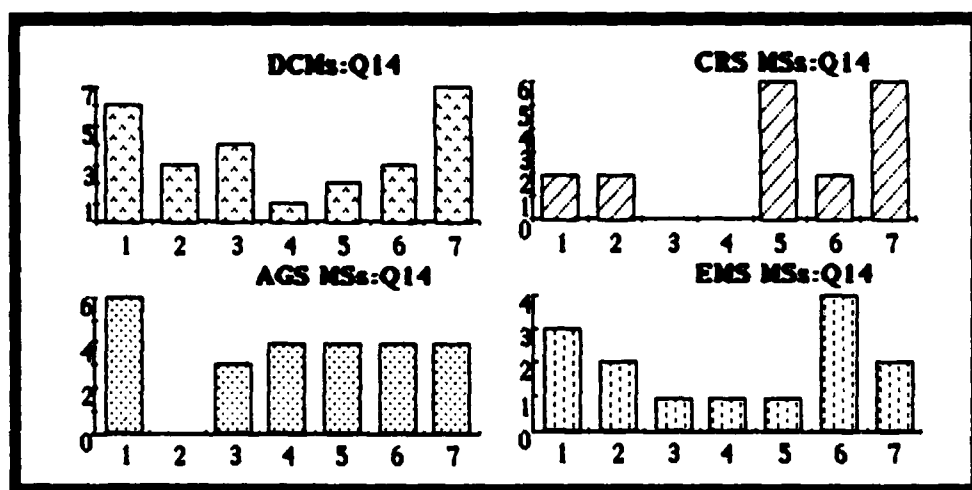


Figure 4.17. Section 2, Question 14 Survey Response Histograms

At first glance, the responses to this question might indicate a poorly worded question. However, this was not the case. Despite the confusing distribution shapes, the "U" tendency did give a hint as to the attitudes of the maintenance managers. The "U" shape indicated that whatever response was chosen, the managers felt very strongly about their positive or negative response. Which managers felt which way could not be determined. As this was the only question in this section with this strong of a "U" shape distribution, further research in this area could be important. Additional analysis could uncover a basic reason why some programs do not do well; if the managers feel the program does not help their efforts or apply to them, then those maintenance managers will not feel the program



is important. In total, the institutionalization of any program with this type of spread of opinions would be very difficult.

Questions 15 & 16: "Blue Two" Visits are helpful for the contractor, AFSC, or AFLC to determine my specific R & M needs; My unit has frequent "Blue Two" Visits. Blue Two visits are part of the education process for the designers and providers of a weapon system. The visits enable the contractors to see "first hand" the problems and constraints that may face TAC maintenance personnel. If the TAC maintenance managers do not support the Blue Two visits, then their wishes or desires for improvements in their weapon system could be hindered. The responses to these questions were anticipated to be on the moderate to high side of the scale.

Helpfulness of Blue Two Visits (Question 15). A wide range of responses were evident for this question. The DCMs displayed a median of 6 with a strong mode of 7. The CRS Maintenance Supervisors' responses were just slightly lower with a median of 5 and dual modes of 5 and 6. As shown by Figure D.22 in Appendix D, the AGS and EMS Maintenance Supervisors tended more towards the middle of the scale. The medians and modes for the AGS and EMS Maintenance Supervisors were the same with 5 and 4 values, respectively. It should be noted that there were, however, only 5 responses on the low side of the scale across all of the maintenance manager categories. Due to the range of modes from 4 to 7, the  $H$  test was necessary. From Table 4.4, it was verified that the probability distributions for this question's maintenance manager categories were indeed different. The null hypothesis was rejected at both the 99% and 95% confidence level.

The results of this question indicated that the managers generally agreed that the Blue Two visits were helpful in determining their R & M needs. A substantial number of managers in the AGS and EMS Maintenance Supervisors categories did answer that they did not agree nor disagree, so the final analysis of this question tended to be inconclusive. Further studies should be initiated to determine the reasons for the AGS and EMS Maintenance Supervisors' noncommittal responses.

Frequency of Blue Two Visits (Question 16). This question was simply posed to find out the extent of Blue Two visits taking place in the Tactical Air Command environment.

The results all showed similar shapes for their response frequency distributions. The medians varied slightly from 2 for the EMS Maintenance Supervisors, to 3.5 for the DCMs, and then to 4 for the AGS and CRS Maintenance Supervisors. The modes also tended to vary slightly. All of the manager categories had modes of 1, but the AGS Maintenance Supervisors' mode was weak with a value of 4 being just one respondent away. Additionally, the CRS Maintenance Supervisors showed modal values of 2 and 4. For the CRS Maintenance Supervisors, the modes were weak; the remaining scale values of 3, 5, 6, and 7 all had two respondents, just one respondent behind the primary tri-modal values. Because of the nonconsensus of the CRS managers, the  $H$  test was required by the research methodology. But, due to the single manager category disagreement, the  $H$  test could not conclude that two of the four distributions were different. Therefore, at both the 95% and 99% confidence

levels, insufficient evidence was available to prove the distributions were not the same. Figure D.22 shows the modal response histograms.

From the results of this question, it could be ascertained that Blue Two visits, though considered important, were not common across all TAC units. Reasons for the strong disagreement of some managers should be looked into further.

Questions 17, 18, 19, & 20: I understand how to compute R & M factors; I understand how to improve R & M factors; My efforts improve R & M factors within my unit; I know how many spaces per aircraft my unit is authorized. These four questions were designed to detect the extent of knowledge the maintenance managers may have concerning the R & M concepts. It was hypothesized that possibly some maintenance managers were already aware of R & M details, even without specific R & M training.

Computing R & M Factors (Question 17). The responses of this question all tended toward the lowest part of the scale. Complete consensus was obtained from all maintenance managers. The medians and modes for all categories carried the value of 1. No *H* test was necessary for this question and the Table 4.4 results verified that this was true. Figure D.23 shows the shapes of the response charts.

Nearly 56% of the respondents felt that they did not understand how to compute the R & M factors in their units. This percentage was unexpectedly high. Additionally, why 78% of the responses fell on the low side of the scale is a question which could not be answered from this level of research. As far as this research is concerned, some factors will be discussed in the analysis of the third section of the survey instrument. Still

further, research needs to be accomplished to find out exactly what the maintenance managers consider to be the R & M factors that they do not understand how to compute.

Improving R & M Factors (Question 18). The emphasis of this question was to determine the extent that the TAC maintenance managers felt that they could improve the R & M factors. It was determined that it would be possible to *improve* the factors of the program, even if a maintenance manager did not know how to *compute* those factors.

The responses to this question did not follow the consensus pattern of the previous question. The DCMs showed a median value of 1 with a mode of 3; several respondents selected the other side of the scale by choosing the "to a great extent" value of 6 for their answer. The AGS Maintenance Supervisors showed similar results with the median again being 3 with a mode of 1. Several of these managers also chose a value of 5 for their response to this question. The EMS Maintenance Supervisors showed a similar distribution but with not as strong of a modal value. Their median was 2 with their mode being a value of 1. The same tendency on the right side of the scale was displayed with these supervisors. Lastly, the CRS Maintenance Supervisors had a median of 3, with dual modal values of 1 and 3. The  $H$  test was required due to the spread of modes from 1 to 3. With the low response rates per scale value in the cases of the CRS and EMS Maintenance Supervisors, the  $H$  test could not prove the response distributions to be different. The observed  $H$  value was much less than the test statistic for the 95% confidence level. This ultimately indicated that statistically, the distributions were the same. As such, any conclusions

made concerning this question would be applicable across all of the maintenance manager categories. Figure D.23 denotes the response frequencies for this question.

Interpretations of the results of this question were difficult. Even though the medians and modes did not show it well, the responses were spread across the entire scale. As such, no sound conclusions could be made concerning the extent of improving the R & M factors in the maintenance managers' units.

Efforts To Improve R & M Factors In Managers' Units (Question 19). This question was designed to further validate any conclusion derived from the previous question. It was primarily intended to personalize the efforts of the maintenance managers to see to what extent they actually improved the R & M factors in their units.

In this case, the DCMs responded with a median of 4 and a moderately weak mode of 2. The AGS Maintenance Supervisors showed a median and mode of 4. The CRS Maintenance Supervisors did not display any consensus. Their median value was 3 with dual weak modes of 1 and 5. The EMS Maintenance Supervisors' response distribution was similar to that of the DCMs. They responded with a 2.5 median value and a modal value of 1. With the spread of responses again across the scale, the  $H$  test was required. With nearly all of the modal response rates being weak, the  $H$  test showed difficulty in proving that the distributions were different. Statistically, at both the 99% and 95% confidence levels, the null hypothesis could not be rejected. This led to the conclusion that the distributions were

the same and again final conclusions would be applicable across all of the manager categories. The response charts are displayed in Figure D.24.

As in the previous question's results, the spread of responses caused difficulty in analyzing any trends across the maintenance manager categories. No definite reasons could be suggested for the variety of responses on both sides of the scale. Another consideration that complicated this question was that if the managers still did not know what R & M factors were being discussed, then they could not possibly know how to improve them. This supports a link between doing and measuring; if managers don't do something, they usually don't measure it.

Spaces Per Aircraft Authorizations (Question 20). This question was included in this training section just as a lead-in to the final tools section of the survey. It was designed to find out the extent that the maintenance managers were aware of a specific R & M factor. Spaces per aircraft are used primarily for manpower authorization determinations. Each unit is usually assigned manpower positions based on a spaces per aircraft (SPA) calculation. It was generally anticipated that many maintenance managers would not relate the SPA factor to the R & M 2000 program and as a result the responses would be typically low.

The DCMs showed the opposite of this question's expectations. With a median of 6 and a mode of 7, the DCMs were the only maintenance manager category to answer with a positive sloping shape of distribution shown in Figure D.24. The AGS Maintenance Supervisors responded with a median and mode of 4. The CRS Maintenance Supervisors showed a median of 3 with dual weak modal values of 1 and 5. The EMS Maintenance

Supervisors answered with a median of 2.5 and a relatively strong modal value of 1. Since the DCMs and EMS Maintenance Supervisors distributions were basically reversed, the  $H$  test was accomplished to statistically show that they were indeed not the same. As seen from Table 4.4, the observed  $H$  value exceeded both the 99% and 95% confidence level test statistic. This indicated that at least two of the four distributions were considered different as the null hypothesis was rejected in both cases.

The results of this question showed that for the most part, the DCMs knew what the term SPA meant. The AGS and CRS Maintenance Supervisors were not in consensus, but did have a majority of responses on the low side of the scale. The EMS Maintenance Supervisors tended to not know how many SPA their units were authorized. Further analysis will be discussed with similar questions in the following survey section's findings.

Question 21: My subordinates have been trained in the R & M 2000 Program policies. This final question in this training and education section was closely tied to the previous questions 5, 6, 10, 11, and 12. Questions 5 and 6 dealt with the training of subordinates and the remaining questions dealt with the training that they may have received. This question was designed to tie the education and training program together and validate the subordinate training issue at the end of this survey section. Hopefully, it would determine the extent that the TAC maintenance managers felt their subordinates were trained on all facets of the program.

The results of this question were initially somewhat confusing. Consensus was reached as the medians ranged from only 1 to 2. The AGS and EMS Maintenance Supervisors tallied the low values of 1, the DCMs

totaled a value of 1.5, and the CRS Maintenance Supervisors' responses resulted in a value of 2. The mode for all manager categories was a very strong value of 1. The *H* test was therefore not required. Table 4.4 again validated the methodology's requirement to not accomplish the statistical test when the medians and modes showed consensus. Figure 4.18 below displays the strong modal responses.

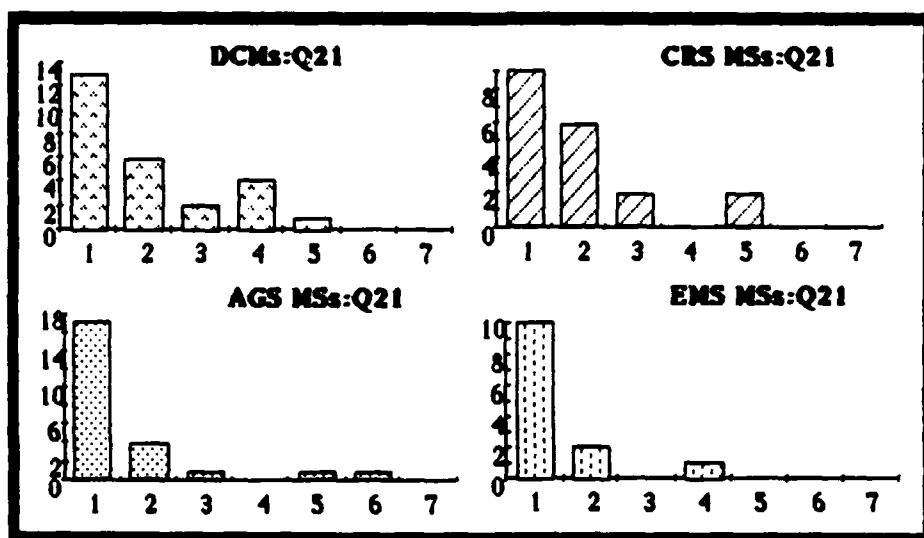


Figure 4.18. Section 2, Question 21 Survey Response Histograms

The responses from questions 5 and 6 tended toward the high side of the scale, but these questions did not address whether the subordinates received training, just those subordinates' understanding of the two main concepts of the program. Generally, the responses to questions 11 and 12 were inconclusive. The results of question 10 were low indicating that insufficient training programs were available. This question's results validate question 10's conclusion in that a substantial number of



maintenance managers felt that their subordinates were not trained in the R & M 2000 program policies.

#### Overview of Section 2: Training and Education in the R & M 2000

Program. The previous twenty one questions were all designed to draw out opinions and attitudes of TAC maintenance managers concerning the degree or extent of training or education they had concerning the R & M 2000 program. The *H* test results aided the analysis process. They detected whether the managers from category to category felt the same way about a particular question. Overall, the manager categories were viewed as being the same. Ultimately, this section led to the uncovering of any maintenance manager trends in the R & M training and education process. Formal training did not appear to be available in TAC. Local training was not available either. Most R & M education was imported via prior training from maintenance managers' previous jobs. Because of this lack of training, the TAC managers did not know generally how to compute or improve R & M factors. Still further, despite the apparent low education and training level, all managers felt training was the key to the success and institutionalization of any new program. To continue the further investigation of the initial research questions as applied to Levy's "core process" dimension of change, the last survey section was analyzed.

Program Tools Identification Survey Responses. [Section 3] The analysis and evaluation procedure for this section was the same as the two previous sections. The median/modal comparison table was again consulted to find any questions with complete consensus. It is important to note that *only one* question, #4, in this section attained complete consensus across all

maintenance manager categories. In this section, many of the questions were directed simply at sight awareness, meaning if a maintenance manager was aware of a certain training concept, then it was assumed that the respondent would answer strongly to either side of the scale. There were three scales used for this part of the survey. Questions 1 through 14 used the extent scale. Questions 15 through 21 used the agree/disagree scale. Finally, questions 22 through 28 used a new time scale, shown on the following page in Figure 4.19. The new time scale was reversed with the higher side of the scale (7) carrying a low value (never) and the lower side of the scale (1) denoting a high value (all of the time).

- |                            |                 |
|----------------------------|-----------------|
| 1. All of the time         | 5. Occasionally |
| 2. Most of the time        | 6. Seldom       |
| 3. A good deal of the time | 7. Never        |
| 4. About half of the time  |                 |

Figure 4.19. Survey Response Scales (Section 3)

Statistical Tests. Once again, the Kruskal-Wallis  $H$  test was conducted for all of the questions in this section of the survey. The  $H$  test results for this section of the survey and their associated confidence levels are displayed in Table 4.5 on the following page. Both the 95% and 99% confidence levels were evaluated. If the observed value fell below the critical value, the distributions were considered the same. Alternately, if the observed value fell above the critical value, the at least two of the four distributions were viewed as statistically different.

Table 4.5. Kruskal-Wallis H Test Results (Survey Section 3)

H<sub>0</sub>: The 4 probability distributions are identical  
H<sub>a</sub>: At least 2 of 4 distributions differ in location

Rejection Region: ( $\alpha = .05$ )  $H > 7.81473$

Rejection Region: ( $\alpha = .01$ )  $H > 11.3449$

[3 degrees of freedom]

Question #	Observed H	$\alpha = .05$	$\alpha = .01$
1	7.3442	SAME	SAME
2	10.7907	DIFFERENT	SAME
3	9.9537	DIFFERENT	SAME
4	5.9054	SAME	SAME
5	6.5612	SAME	SAME
6	5.9627	SAME	SAME
7	18.5244	DIFFERENT	DIFFERENT
8	9.8622	DIFFERENT	SAME
9	5.7656	SAME	SAME
10	4.6419	SAME	SAME
11	7.2079	SAME	SAME
12	9.3794	DIFFERENT	SAME
13	18.1895	DIFFERENT	DIFFERENT
14	8.0651	DIFFERENT	SAME
15	9.2636	DIFFERENT	SAME
16	7.3803	SAME	SAME
17	6.4406	SAME	SAME
18	6.8171	SAME	SAME
19	10.6104	DIFFERENT	SAME
20	3.7155	SAME	SAME
21	4.4792	SAME	SAME
22	10.3960	DIFFERENT	SAME
23	6.6400	SAME	SAME
24	4.9170	SAME	SAME
25	13.2506	DIFFERENT	DIFFERENT
26	4.4375	SAME	SAME
27	3.7450	SAME	SAME
28	3.9705	SAME	SAME

Questions 1, 2 & 3: I know what tools are at my disposal for measuring R & M in my unit; I use the tools at my disposal for R & M management; I have the time to use the tools necessary for improving R & M. These first three questions were all designed to determine the extent that the maintenance managers were aware of and used the R & M management tools. It was predicted that these questions' answers would at least fall on the high side of the scale and only vary slightly in extent.

Knowledge of R & M Tools (Question 1). This first question's responses did not follow expectations. The DCMs median was the highest with a value of 3. The CRS and EMS Maintenance Supervisors showed medians of 2, and the AGS managers responded with a median of 1. All of the modes carried the value of 1 and were relatively strong as seen be Figure D.26. The variation in the median of more than one scale value required the *H* test to be conducted. Although the medians showed some differences, it could not be proven statistically that the distributions were different. Neither the 99% nor 95% confidence level test statistics were low enough compared to the observed *H* value to reject the null hypothesis.

The results of this question did not follow the expectations for responses from the TAC maintenance managers. The strong tendency that they were aware of the R & M tools only "to a very little extent" indicated there was indeed a significant lack of R & M education amongst the respondents. Additional questions tried to delve deeper into this concept and possibly find out the managers awareness level of the R & M tools.

Use of R & M Tools (Question 2). Amongst those who did know of the tools of the program, this question was aimed at determining the extent

that they actually used those tools. The expectations, as previously mentioned, were that the responses would at least be on the high side of the scale. However, after the results of the previous question were analyzed, the expectations were amended to predict significantly lower responses.

The amended prediction was closer to the actual results. The DCMs' responses spread out across the scale with a median of 4 and a weak mode of 1. However, the DCMs were the only group to be affected by this dispersion tendency. All of the Maintenance Supervisors stayed with a mode of 1, with medians ranging from 1.5 to 2. Figure D.26 shows this questions' survey response histograms. Again, because of the varied responses from the DCMs, the  $H$  test was required. The  $H$  test results showed that the managers' response distributions were considered different at the 95% confidence level and the same at the 99% confidence level. In addition to the different DCM responses, the lack of the EMS Maintenance Supervisors higher scale responses could have contributed to the rejection of the null hypothesis at the 95% confidence level. However, this difference was not strong enough for the same conclusion to be made at the 99% confidence level.

The DCMs displayed a "U" shaped distribution. Thus, it could be concluded that strong feelings were evident with those managers. It just could not be agreed upon as to which side of the scale was the best answer for all. The Maintenance Supervisors, possibly because most of them were not *aware* of the tools, could not indicate that they *used* those tools. Further research is necessary to find reasons for the use or nonuse of the R & M tools.

Time Availability for Use of R & M Tools (Question 3). The

purpose of this question was to determine, of those who did use the tools, the extent to which they felt if they had the time to use those tools. Again, an amended hypothesis expecting lower responses was proposed.

As seen from Figure 4.20 below, the results of this question showed two types of response distributions. The DCMs and EMS Maintenance Supervisors generally had similar medians and modes, whereas the AGS and CRS Maintenance Supervisors showed similar tendencies. In the cases of the DCMs and EMS Maintenance Supervisors, the responses were generally weak and spread across the scale. The other two categories showed strong modes of 1 with medians of 2. The  $H$  test was accomplished due to the apparent grouping differences between the manager categories.

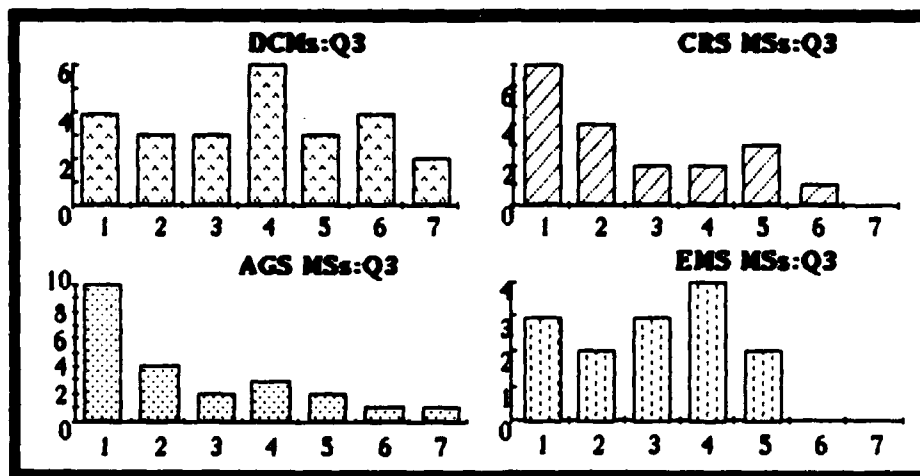


Figure 4.20. Section 3, Question 3 Survey Response Histograms

Generally, the DCMs and EMS Maintenance Supervisors could not agree with the extent of time they felt available to use the R & M tools. On the

other hand, the AGS and CRS Maintenance Supervisors felt strongly that they only had time to use the tools "to a very little extent."

Questions 4, 5, 8, 10, 11, 17, & 22: I use Quality Assurance for checking on aspects of R & M in my unit; PIWGs have an impact on improving R & M in my unit; In my weapon system, there are similar standard operating, maintenance, and testing characteristics across similar subsystems; I have initiated a warranted tool program; I use the Suggestion Program to get modifications incorporated into a unit; "Blue Two" Visits are an effective part of managing how the contractor, AFSC, or AFLC sees the defects of particular items in my unit; I attend Product Improvement Working Groups (PIWG) as they are held for my weapon system. This long list of questions was grouped together because they all involved questions relating to maintenance programs already in place that were determined to be capable of helping the manager with R & M concepts. As these programs were already functioning within the maintenance complex, it was expected that the responses to these questions would fall on the higher side of the scale.

Quality Assurance (QA) Program Use (Question 4). The specific intent of this question was to determine the extent that the maintenance managers felt that the QA program was available to assist in R & M type actions.

The DCMs responded with a median of 5 and the remaining categories responded with a median of 4. The modes were all on the high side of the scale, validating the initial hypothesis of responses for this group of

questions. Figure D.27 shows the DCMs dual mode of 5 and 6; the Maintenance Supervisors all had modes of 5. Both the AGS and EMS Maintenance Supervisors modes were weak with the second highest responses falling just one respondent short. No  $H$  test was necessary for this question.

Overall, the maintenance managers from all categories generally used QA to help check on aspects of the R & M 2000 program in their units.

Impact of PIWGs (Question 5). This question, as well as a later question, was designed to just detect the impact level that the maintenance managers felt that PIWGs had on the R & M 2000 program.

This question nearly attained consensus. The DCMs had the highest median with a value of 5.5. The AGS and CRS Maintenance Supervisors followed next with values of 5. Finally, the EMS Maintenance Supervisors displayed a median value of 4. The modes were slightly more inconsistent. The DCMs responses showed the highest frequency with the value of 6. The AGS and CRS Maintenance Supervisors both had modal values of 5. Finally, the EMS Maintenance Supervisors displayed the lowest mode of 4. This value was considered weak as the second highest response values of 2, 3, 5, and 6 were just one respondent behind. The lower modal value of the EMS Maintenance Supervisors caused the requirement for the  $H$  test. Because this question nearly attained consensus from the analysis of the medians and modes, it was difficult for the  $H$  test to detect anything different. Table 4.5 shows that the response distributions were the same at both confidence levels. The null hypothesis could not be rejected after the rank sums of the categories were evaluated and an observed  $H$  value was



determined. Figure D.28 shows the response charts for this question.

Overall, nearly 66% of the managers answered on the higher side of the scale. Thus, it could be concluded that the PIWGs had an impact on improving the R & M in the managers units to a "fairly large extent."

Attendance of PIWGs (Question 22). The purpose of question 22 was to detect how often the managers actually attended the PIWGs. As they generally felt that the PIWGs aided them as managers, the expected response should be that they attended the meetings at least "about half of the time." It is important to remember that the scale in this case was reversed.

On the following page, Figure 4.21 displays the responses for the maintenance managers for this question. The DCMs appeared to respond differently than the remaining categories of managers. The DCMs had a median of 5 with dual modal values of 6 and 7. However, a significant number of managers also responded that they attended "all of the time." The remainder of managers answered on the right side of this scale. They all had medians and strong modes of 7, indicating they "never" attended PIWGs. An  $H$  test was conducted to prove the DCMs response probability distribution was indeed not the same as the rest. At the 95% confidence level, the null hypothesis that the distributions were identical was rejected. However, at the 99% confidence level, insufficient evidence was present to reject the null hypothesis. This indicated that with the higher level, at least two of the four distributions were not different. This does not conflict with the median and modal results showing that only the DCMs significantly disagreed with the other managers.

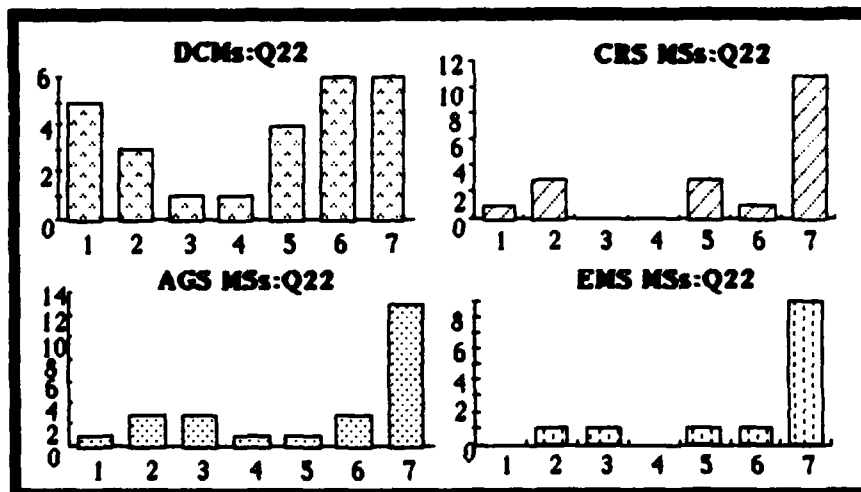


Figure 4.21. Section 3, Question 22 Survey Response Histograms

Even though the managers felt the PIWGs were important, they did not all attend frequently. Only the DCMs showed a tendency to attend "occasionally." Since no reasons were solicited for these non-attendance results, no definite conclusions could be made concerning the usefulness of PIWGs as an R & M management tool. Further research should be accomplished in this area to better determine the possible R & M benefits of the PIWG program.

Standard Operating Characteristics (Question 8). One possible way of improving the reliability and maintainability of any weapon system would be to ensure that there exist standard operating, maintenance, and testing characteristics across similar subsystems of that weapon system. This question was aimed at discovering the extent of standard procedures across an entire weapon system's spectrum.

The medians of this question showed consensus for all of the manager categories. The values of 4 for the DCMs and 5 for all of the Maintenance

Supervisors did not vary by more than one. However, a slight shift of one category's mode caused the  $H$  test to be necessary. The DCMs had dual modes of 4 and 5. The AGS and CRS Maintenance Supervisors had strong modes of 5. Finally, the EMS Maintenance Supervisors showed a weak mode of 6, with the values of 2, 4, and 5 falling just one respondent behind. With the near consensus of this question's results, the  $H$  test did not prove that at least two out of the four response distributions were different. The observed  $H$  value, shown in Figure 4.5, was lower than both the 99% and 95% test statistics. The null hypothesis could not be rejected in this case. Figure D.29 shows this question's modal response histograms.

As the mode for the EMS Maintenance Supervisors was considerably weak, it could generally still be concluded that a consensus was evident across all of the maintenance managers. They felt to a "fairly large extent" that standard operating characteristics were evident across similar subsystems of their own weapon system. This characteristic was considered a management emphasis area as per the "Technician Transparency" Building Block (reference Figure 1.1) of the R & M 2000 program.

Warranted Tool Program (Question 10). This question was intended to detect the extent the maintenance managers had initiated warranted tool programs in their units. As warranted tool programs save money in the long run, it was expected that the responses would still tend toward the high side of the scale.

The results did not turn out as expected. The DCMs and CRS Maintenance Supervisors displayed medians of 2 with strong modes with

the value of 1. The AGS Maintenance Supervisors had just a one value higher mode of 3 while still tallying the same strong mode of 1. The EMS Maintenance Supervisors showed no consensus at all. Their median of 4 was the first indication of a broad spectrum of answers. The weak tri-modal values of 1, 2, and 5 further showed significant disagreement, ranging from one side of the scale to the other. The EMS Maintenance Supervisors had a maximum of only two respondents answer at any scale value. This lack of consensus by the EMS Maintenance Supervisors necessitated the accomplishment of the  $H$  test to prove the distributions of all of the maintenance managers were not the same. Figure D.30 shows the modal response frequencies for this question. With only one manager category varying significantly from the others, the  $H$  test could not conclude that at least two of the four distributions were different. Table 4.5 shows that the observed  $H$  value was much lower than either of the confidence level test statistics. Again, this statistical conclusion does not necessarily conflict with the statement that only the EMS Maintenance Supervisors appeared to have different response results.

Warrantied tool programs ultimately affect the R & M program at the "Simplification" Building Block level of the R & M 2000 Process. Since the EMS Maintenance Supervisors did not reach an agreement, their responses skewed the results of this question. For the majority of the other maintenance managers, they had initiated warrantied tool programs only "to a very little extent." However, this could be a misleading conclusion. Nothing in this question states whether a unit might have already had such a program already in existence. Further research should be conducted to determine reasons for most units not having warrantied tool programs.

### Use of the Suggestion Program to Incorporate Modifications

(Question 11). One means of incorporating new modifications into a weapon system is through the use of the Suggestion Program. This method is usually the result of some technician wanting to improve the way a part is constructed, or the way a job is accomplished. Usually, in order for the suggestion be accepted, it must be able to save money over the previous way of doing things. As such, the program is a valid R & M 2000 program cost reducing tool. The intent of this question was to determine the extent of the encouragement of the use of the Suggestion Program by maintenance managers in TAC.

All of the distributions of responses appeared to be different. As seen in Figure D.31, only the DCMs had some type of grouping of respondents. The remainder of the distributions varied significantly. The small number of Maintenance Supervisor respondents for any one scale value reinforced the nonconsensus appearance of these distributions. The  $H$  test was definitely required for this question. Despite the apparent median and modal differences, no statistical differences could be detected. The  $H$  test revealed that the null hypothesis could not be rejected at the 99% or 95% confidence levels. The low response rates for any single scale value for all of the Maintenance Supervisors most likely contributed to the inability of the test to distinguish between the distributions.

Since the response distributions varied so greatly and no general trends could be detected, no conclusions could be proposed. Additional research could uncover reasons for the disagreement amongst the maintenance managers concerning the use of the Suggestion Program.

Blue Two Program Effectiveness (Question 17). In the previous section, two education and training questions were asked concerning the Blue Two program. As previously shown, although the program was considered important, visits were infrequent. The purpose of this question was to go beyond the importance level and determine the effectiveness of the Blue Two visits.

This question partly followed the expectations of results on the high side of the scale. The DCMs responded with a median and mode of 6. The CRS Maintenance Supervisors answered slightly lower on the scale with a median and mode of 5. The AGS and EMS Maintenance Supervisors stepped one scale value lower with medians and modes of 4. All of the modes in all of the categories were considered strong. The  $H$  test was only required because of the two value shift from the DCMs to the AGS and EMS Maintenance Supervisors. As only one manager category seemed to be different from the remaining categories, it followed that the  $H$  test could not detect statistically that possibly two of the four distributions were different. Table 4.5 shows the low observed value in comparison with the test statistics for the 95% and 99% confidence levels. The null hypothesis in this case was not rejected. Figure D.34 depicts the modal response charts for this question.

Nevertheless, these results were not totally conclusive, as the AGS and EMS Maintenance Supervisors showed a tendency to respond with the neither agree nor disagree scale value. A possible reason for this conclusion, though unsupported, might be that the Blue Two visits were actually occurring in the CRS shops and sections, and as such, they felt the program

was more beneficial for them. As previously mentioned in other question analyses, if the impact of the Blue Two program was not known, then this might have caused maintenance managers not to be wholeheartedly supportive of that program.

Questions 6, 7, 15, 16, & 28: I know the meaning of "Double R/ Half M;" I know what the minimum specifications for mean time between failure (MTBF) are for the avionics units in my weapon system; MTBFs for most of the avionics in my weapon system are realistic; If a unit fails to meet its warranty, I have the ability to process the return of that unit;  
"Double R/Half M" is an attainable goal. The purposes of these five questions were to determine awareness by sight recognition of some of the R & M 2000 precepts. High responses for the responses of these questions might indicate some awareness of the precepts of the R & M 2000 program, despite the program's low level of education.

Meaning of "Double R/Half M" Concept (Question 6). The concept of Double R/Half M, first set forth in the second R & M policy letter issued by the Vice Chief of Staff, indicated that new systems should be expected to have at least double the reliability and half of the maintainability of their predecessors.

The results of this question nearly gained consensus. The DCMs answered with a median and very strong mode of 1. The AGS Maintenance Supervisors had a median of 4, but still had a strong single mode of 1. The CRS Maintenance Supervisors mimicked the DCMs with the same values. Finally, the EMS Maintenance Supervisors showed a slightly less degree of agreement. Almost 55% of the respondents did respond on the lower side of

the scale with values of 1 through 3. However, as there were a few that still responded to the right, the EMS Maintenance Supervisors' median was shifted to the value of 3. The variations in the medians for the manager categories gave rise to the requirement to conduct the statistical  $H$  test. This variation, however, was not large enough to affect the rank sums of the  $H$  test. The null hypothesis could not be rejected at either confidence level, any conclusions would apply to all managers in all categories. Figure D.28 in Appendix D shows the near consensus results for this question.

Overall, a majority of managers (51.9%) answered with a scale value of representing the attitude "to a very little extent." As such, it may be concluded that the TAC maintenance managers were not aware of the "Double R/Half M" concept of the R & M 2000 program.

Attainable "Double R/Half M" Concept (Question 28). This question, placed last in this survey, was designed to validate the "Double R/Half M" concept by determining if the maintenance managers felt the concept was attainable.

Figure 4.22 on the next page shows the modal distributions for this question. As can be seen, the medians stayed generally consistent with values of 3 and 4. The modes of the AGS and EMS Maintenance Supervisors, however, shifted to the left of the DCMs and CRS Maintenance Supervisors. It should be noted that a significant number of respondents, 29.8% of the managers, left this question blank. Following the instructions indicating that if the question was not applicable, they should have left it blank. The  $H$  test was still required because of the variation of modes. Since the response rate for any one scale value was low, the  $H$  test could



not distinguish any statistical differences between the distributions. At both the 99% and 95% confidence level, the observed  $H$  value was well below the test statistic. This indicated that the null hypothesis could not be rejected and the distributions were generally considered as being similar.

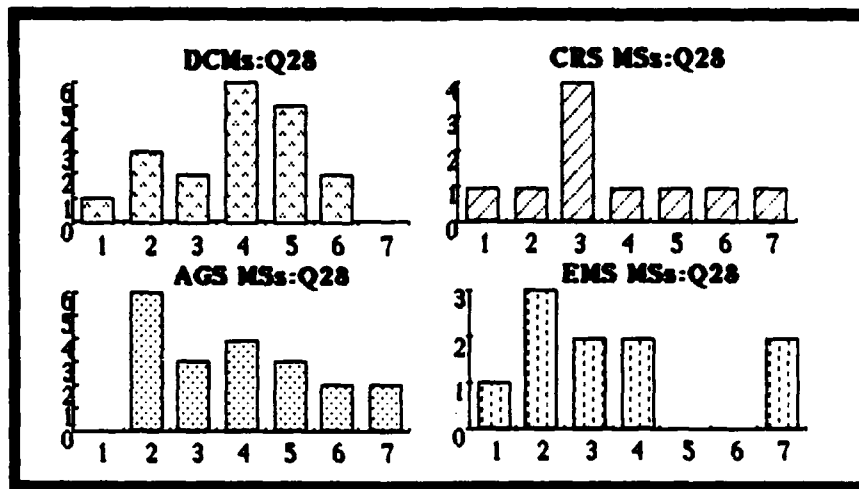


Figure 4.22. Section 3, Question 28 Survey Response Histograms

Due to the large number of non-responses, any conclusion for this question was relatively biased, compared to other results. Since the non-respondents ranged across all maintenance manager categories and did not overly affect any one category, the results were still considered valid to be applied to the whole of the TAC maintenance managers. Overall, of the managers who knew the meaning of the "Double R/Half M" goal, they felt it was attainable at least "a good deal of the time."

#### Knowledge of MTBFs for Avionics Units in Weapon System

(Question 7). The aim of question 7 was to determine the extent that TAC maintenance managers were aware of the mean time between failures for

the avionics units on their weapon systems. Tracking MTBFs was considered a tool available for the management of the R & M 2000 program.

Both the DCMs and the CRS Maintenance Supervisors tallied median values of 3. However, their modes varied slightly as the DCMs responded with a mode of 1 and the CRS Maintenance Supervisors responded with a mode of 3. The EMS Maintenance Supervisors showed similar results to the DCMs, but they had both a median and a strong mode of 1. The AGS Maintenance Supervisors' response distribution was just the opposite of the other manager categories. Their median value was 5 with a mode of 6. As such, the  $H$  test was necessary to show the statistical differences between the distributions. With the wide range of responses, the statistical  $H$  test easily determined that at least two of the four distributions were not the same. The null hypothesis at even the 99% confidence level was strongly rejected. Table 4.5 shows the statistical values for this question. Figure D.29 displays the response charts for this question.

The results of this MTBF awareness question indicated that the AGS Maintenance Supervisors felt that they, to at least a great extent, knew the MTBFs of their avionics units. This made sense as the AGS Maintenance Supervisors commonly were aware of when particular units failed on their aircraft, thus requiring some type of maintenance action. Almost 39% of the other managers felt they only knew their avionics units' MTBFs to a very little extent. It is possible that since they did not deal with the failures directly on the weapon system, they felt they were not aware of those avionics units' failure rates. Further research in this area should be conducted to determine why the AGS Maintenance Supervisors' responses differed so greatly from the other managers.

Realism of MTBFs in Weapon System (Question 15). The aim of this question was to validate whether the avionics systems' MTBFs were even considered to be realistic in the eyes of the TAC maintenance managers. With the results of the previous question indicating that the AGS Maintenance Supervisors had a more acute awareness of the MTBFs of their weapon systems, the results of this question were expected to be similar.

The distribution of responses did not turn out as anticipated. As seen in Figure D.33, the DCMs showed generally inconsistent responses with a median of 3.5 and dual modes of 3 and 5. The AGS Maintenance Supervisors displayed the most conclusive responses by answering with a mode of 5 and a median of the same value. Additionally, the EMS Maintenance Supervisors showed some consensus with a median and mode of 4. The CRS Maintenance Supervisors followed suit with the DCMs and could not agree on a consistent answer. Their median was 4 with a very weak mode of 3. The next highest responses of 4, 5, and 6 for the CRS Maintenance Supervisors fell only one respondent short of the mode. With the dual modes of the DCMs ranging on both the high and low sides of the scale, as well as their modes being more than one scale value apart from the rest of the managers, the  $H$  test was necessary. It revealed that with a 95% confidence level, the null hypothesis was rejected and the distributions were viewed as being different. However, the differences were not strong enough to reject the null hypothesis at the 99% confidence level. The low response rates and responses spread across the entire scale for most of the manager categories could have caused the inability of the test to detect differences at a higher confidence level.

Valid conclusions could only be made concerning the AGS and EMS Maintenance Supervisors. These two sets of managers slightly agreed that the MTBFs for their avionics were realistic. Both the DCMs and CRS Maintenance Supervisors responses proved to be inconclusive. Continued research should investigate reasons for the possibly nonrealistic MTBFs.

Ability To Process Failed Unit Warranties (Question 16). This question was constructed to find out the extent that TAC maintenance managers felt they had the capability to return failed warranty items. The answers were, as previously stated, anticipated to be on the high side of the scale.

On the following page, the response charts in Figure 4.23 collectively depict the trend toward the high side of the scale as expected. The DCMs and AGS Maintenance Supervisors maintained medians with a scale value of 5. Both the CRS and EMS Maintenance Supervisors responded with a median value of 6. Despite this apparent consensus, the modes were slightly more spread apart. The DCMs showed a weak mode of 7, while the AGS Maintenance Supervisors responded with a dual mode of 5 and 6. The CRS Maintenance Supervisors tallied a mode of 6, as did the EMS Maintenance Supervisors. In addition, the EMS managers also had a dual modal value of 4. The wide variation of modes caused the  $H$  test to be required. However, because the EMS and AGS Maintenance Supervisors did not strongly respond at any one scale value, the  $H$  test could not verify the distributions were different. At both the 99% and 95% confidence levels, the observed  $H$  value fell outside the rejection region and the null hypothesis could not be rejected. As such, any conclusions made for this

question would be generally applicable across the entire span of maintenance managers.

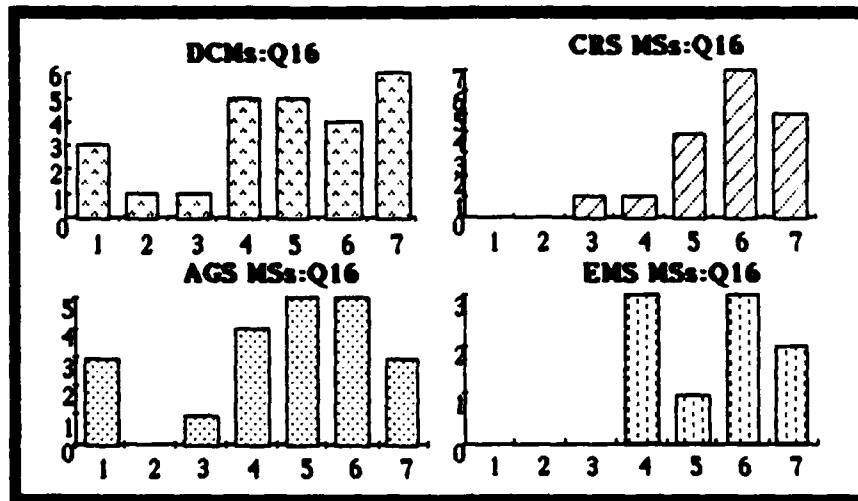


Figure 4.23. Section 3, Question 16 Survey Response Histograms

For the most part, all of the maintenance managers felt they could process the return of a failed part that was under warranty. Just over 68% of the managers agreed at least slightly that they could return the failed item. It must be noted that this conclusion may have also depended on other factors, such as the rapport of the managers with Base Supply, as well as the policies of the contractors dealing with the failed parts. Additional research needs to be accomplished to determine the level of interaction between any factors affecting this question's conclusion.

Questions 9, 23, & 25: Repeatable fault isolation indications show up in the lowest possible field replaceable modules; My unit processes an inordinate number of Quality Deficiency Reports; Production drawings for new items in my unit are readily available. This group of questions were

designed to find the extent that the maintenance managers were aware of these concepts and in some cases, determine how much the managers used those concepts to possibly improve R & M in their units.

Repeatable Fault Isolation Indications (Question 9). This question caused a lot of problems with a significant number of respondents. A large number of people did not understand what this question meant as was indicated by some handwritten comments to the side of the question. In the "Technician Transparency" Building Block of the R & M 2000 process, it states that repeatable fault indications should isolate failures. This isolation should take place, according to the process, at the lowest field replaceable module. The responses to this question were expected to tend toward the middle of the scale.

There was nearly a consensus amongst the managers for this question. The medians for the DCMs was 3. All of the Maintenance Supervisors had medians of 4. The modes only varied slightly, but enough to necessitate the  $H$  test. The DCMs showed weak dual modes of 3 and 4. The AGS Maintenance Supervisors also had dual modes, but carried values of 4 and 5. The CRS and EMS Maintenance Supervisors had single modes indicating a value of "neither moderate nor great extent." The results of the  $H$  test shown in Table 4.5 indicate the null hypothesis could not be rejected. Thus, the distributions were considered the same or at least two of the four distributions were not different. This did not conflict with the median and modal results as the DCMs were the only category to vary from the remaining managers. Figure D.30 in Appendix D shows this question's response distributions.

The results turned out as expected. Though not overly strong, the modes and medians tended toward the center of the scale. As such, the results of this question were considered inconclusive with further research encouraged to determine why many managers were not aware of the concept of repeatable fault isolation indications.

Quality Deficiency Reports (QDRs) (Question 23). This question was aimed at detecting the level of QDRs that maintenance managers felt they processed. This level would give another possible indication of the emphasis level of R & M in the managers' units.

The responses for this question tended to the "occasionally" level on the response scale. The DCMs responded with a median of 4.5 and tri-modal values of 3, 5, and 6. The AGS Maintenance Supervisors had a median of 4 with a mode of 5. The CRS Maintenance Supervisors were slightly higher with a median of 5 and dual modes of 5 and 6. Still higher responses came from the EMS Maintenance Supervisors. They had a median of 5.5 with a mode of 6. The  $H$  test was required because of the shift in modes from 3 to 6. As seen from Table 4.5, the observed  $H$  value for this question was just lower than the 95% confidence level test statistic. Thus, the null hypothesis could not be rejected and at least two of the four distributions could not be viewed as different. The relatively weak modal values of the DCMs and CRS Maintenance Supervisors could have contributed to the failure of the statistical test to verify substantial variations in the managers' probability distributions. Figure D.37 in Appendix D displays this question's response histograms.

As expected, the maintenance managers at least occasionally felt they processed an inordinate number of QDRs. It should be noted that using QDRs was but one way of providing feedback for the R & M 2000 program. Thus, the QDRs, though not used frequently, were still used as an R & M tool by almost all of the maintenance managers at one time or another.

Availability of Production Drawings for New Items (Question 25).

Constructed to determine the use of another R & M tool, this question simply tried to detect if the maintenance managers were aware of the availability of production drawings in their units. As this question specifically applied to new items, the responses were expected to range from about half of the time to a good deal of the time.

The responses for this question spread across the entire spectrum of the scale. As can be seen from Figure D.38, the distributions from category to category were not similar. The DCMs showed a median and modal response with the value of 5. The AGS Maintenance Supervisors showed the same median, but their mode shifted to 4. The CRS Maintenance Supervisors incurred a median of 4.5, carrying tri-modal values of 3, 5, and 6. The EMS Maintenance Supervisors had a weak mode of 3 with the same median value. The methodology of this research required the  $H$  test in this case. At both the 95% and 99% confidence levels, the observed  $H$  value was above the test statistic. The null hypothesis was rejected and it could be concluded that at least two of the four distributions were not the same. The AGS and EMS Maintenance Supervisors tended to respond similarly, but the other two categories had varied responses.



Nevertheless, with 51.9% of the respondents answering on the scale using the time values from "occasionally" to "never," a conclusion could be made that half of the maintenance managers felt production drawings were not usually available. Further research should be conducted to determine why those managers felt the production drawings for new items were not available for their use.

Questions 12, 13, & 18: The maintenance and test equipment requirements for new parts or improvements with my weapon system are compatible with existing equipment; Technical data changes to improve the understandability of troubleshooting and repair techniques are readily accepted through technical order change channels; If I find a better way to access a unit in my weapon system, my inputs will be heard and taken into consideration. The purpose of these questions was again to detect the extent that TAC maintenance managers actually used these tools of the R & M process. These questions all involved compatibility and ways that changes take affect in the maintenance managers' units.

Maintenance and Test Equipment Improvements Compatibility (Question 12). This question was specifically asked to find the extent that the maintenance managers felt that newly designed parts or improvements were still compatible with existing equipment.

The results of this question showed that the Maintenance Supervisors were in general agreement, but the DCMs showed the opposite tendencies. The DCMs displayed a median of 3.5 with a relatively weak mode of 3. Their response distribution was basically negatively sloped. In contrast, the

Maintenance Supervisors' distributions were basically positively sloped. The AGS and EMS Maintenance Supervisors both had a median of 5 with strong modes of the same value. The CRS Maintenance Supervisors shifted slightly to the left with their median of 4.5, but their mode was still the same. The different opinions of the DCMs necessitated the  $H$  test. With the near consensus of the Maintenance Supervisors, the  $H$  test could not strongly conclude that two of the four distributions were different. At the 99% confidence interval, the null hypothesis was not rejected. Table 4.5 shows the observed  $H$  value in comparison with the test statistics. Below, Figure 4.24 shows the alternating slopes of the responses distributions.

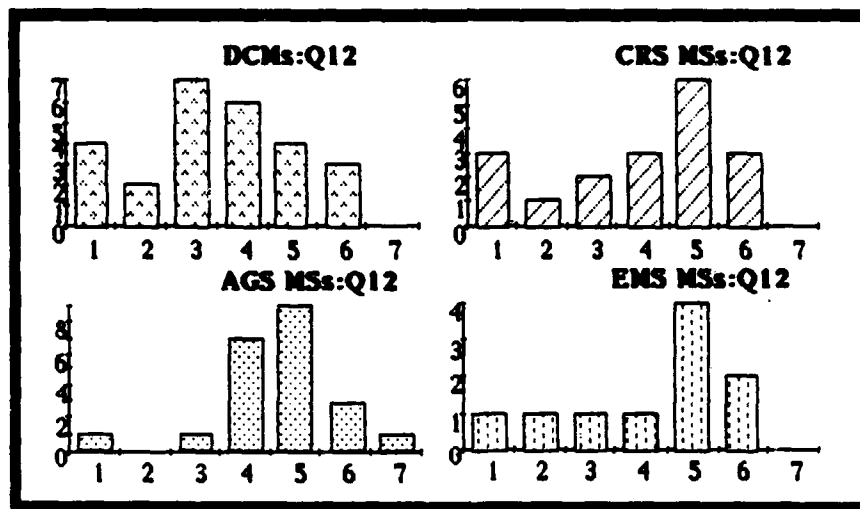


Figure 4.24. Section 3, Question 12 Survey Response Histograms

It could be concluded from this analysis that the DCMs felt that new improvements only moderately were compatible with their existing equipment. The majority of Maintenance Supervisors felt at least to a fairly large extent that there was compatibility. Further research might uncover

why the DCMs felt on the low side of the scale that new improvements were not always compatible with existing equipment.

Acceptability of Technical Order Changes (Question 13). The purpose of this question was to determine the acceptance level of technical order changes involving R & M improvements in the field. It was hypothesized that many changes in the past may not have been readily accepted through the technical order change channels and therefore the TAC maintenance managers would not strongly support future changes.

The responses of this question generally indicated consensus amongst the Maintenance Supervisors, but the DCMs differed in their opinions. The DCMs tallied a median of 3 with the same modal value. On the other hand, the AGS and CRS Maintenance Supervisors showed medians of 5, with the EMS Maintenance Supervisors just having a slightly higher median of 5.5. The AGS, CRS, and EMS Maintenance Supervisors' modes were 1 and 5, 6, and 7, respectively. With the dual mode of the AGS Maintenance Supervisors, the  $H$  test became necessary. The statistical test strongly verified that at least two of the four distributions were not the same. The observed  $H$  value fell in the rejection region for both the 99% and 95% confidence intervals. Figure D.32 displays this questions response charts.

Overall, the DCMs and some of the AGS Maintenance Supervisors were not pleased with the acceptance level of technical order changes. The CRS and EMS Maintenance Supervisors appeared to be satisfied to at least a great extent that changes were readily accepted. Further research should be conducted to possibly determine the effects of the acceptance levels of this R & M tool. Other factors, such as depot technical order change

acceptance policies, should be analyzed to determine possible connections with this question and the institutionalization process.

The Consideration of a Possible Better Way (Question 18). This question was intended to be vague, but still determine the extent that inputs from the maintenance managers in the field were being "heard." Being "heard" encompassed feeling whether the field maintenance managers felt their inputs were being considered during the design of improvements for their weapon system or whether the managers felt they were being supported in trying to improve the R & M of their weapon system.

The medians for all categories were the same, carrying a value of 5. The modes varied just enough to cause the need for the  $H$  test. The DCMs showed a mode of 5, whereas the AGS and CRS Maintenance Supervisors responded with a mode of 6. The EMS Maintenance Supervisors' mode was shifted slightly to the left on the scale with a value of 4. The results of the  $H$  test, shown in Table 4.5, indicated that the distributions did not significantly differ enough to prove that at least two of the four distributions were not the same. The near consensus by median and mode evaluation validated the findings of the statistical test. Figure D.34 in Appendix D shows this question's probability distributions.

In general, the distributions of responses nearly gained consensus. Only the mode of the EMS Maintenance Supervisors was slightly different. However, almost 55% of the EMS managers' responses fell between the values of 5 to 7. As a result, it could be concluded that the maintenance managers slightly agreed that their inputs were being "heard." To find out

why some of the managers felt their inputs were not being considered, further investigations should be made in this area.

Questions 19, 24, & 26: In the case of new modifications, the preventive maintenance schedules are realistic; Hardware and software anomalies in my unit are reported to the contractor, AFSC, or AFLC then solved (as opposed to solving them at my level and then reporting the corrective action); In the case of new modifications or equipment improvements, the contractor is readily available to assist with problems.

These three questions tried to uncover attitudes concerning the level of support that the maintenance managers felt they were receiving with new improvements to their weapon system. It was expected that the consensus of opinions would fall just to the high side of the middle of the scale.

Realistic Preventive Maintenance Schedules (Question 19). The specific purpose of this question was to detect if the any new preventive maintenance schedules were realistic. This meant the schedules provided accurate information as to why and exactly when the new component was supposed to fail and be replaced or repaired.

The DCMs, as seen from Figure D.35, showed a very strong consensus with their median and modal response indicating they neither agreed nor disagreed. The Maintenance Supervisors answers shifted just to the right of the DCMs. All of the Maintenance Supervisors had medians of 5 and modes of the same value. In addition, the CRS Maintenance Supervisors had a dual modal value of 6, causing the  $H$  test requirement. The results of the  $H$  test somewhat validated the median and modal comparisons. At the 95% confidence level, the null hypothesis was rejected and the distributions

could be considered different. However, at the 99% confidence interval, the responses distributions did not differ enough to allow the same rejection of the null hypothesis to occur. As previously stated, the primary disagreement for this question came from the DCM maintenance managers.

Including the scale value of 4, over 85% of the responses were on the right side of the scale. This indicated that the maintenance managers did feel that the preventive maintenance schedules were generally realistic. This further indicated that they were aware of this type of R & M tool and its possible benefits.

The Solving of Hardware and Software Anomalies By Outside Agencies (Question 24). The purpose of this question was to gain information concerning the opinions of the support the 'users' were receiving from various outside agencies. The outside agencies included contractors, AFSC, and AFLC, all of which should be intimately involved in solving hardware and software problems with new components.

The responses showed a wide dispersion of attitudes. The DCMs, had a median of 3.5 with a mode of 2. This distribution did not match any of the other categories. Despite all of the Maintenance Supervisors having medians of 4, this did not give a true indication of their response distributions. The AGS Maintenance Supervisors had a dual mode of 4 and 5, whereas the CRS Maintenance Supervisors had a mode of 2. Still further, the EMS Maintenance Supervisors showed a dual mode of 3 and 6. As virtually no consensus was obtained, the  $H$  test should have proved statistically that they were indeed not the same distributions. However, this was not the case with the statistical test. At both the 99% and the 95%

confidence levels, the observed  $H$  value was not large enough to reject the null hypothesis. As a result, at least two of the four response distributions could not be considered different. The weak response rates for any one scale value was most likely the factor which caused the inability of the  $H$  test to distinguish significant differences between the managers' responses. Charts of these distributions can be viewed in Figure D.37 in Appendix D.

Despite the results of the  $H$  test, no modal or median consensus was available with this question. Therefore, no strong conclusions could be made concerning the extent of the maintenance managers feelings. However, there was some tendency for the DCMs and the CRS Maintenance Supervisors to both feel that the outside agencies were helping solve their problems at least most of the time. The AGS and EMS Maintenance Supervisors generally felt that they were left more to solving their own problems and then reporting the corrective actions. Further investigations of these attitudes could show why some maintenance managers felt isolated and why they always had to solve their own problems. This could ultimately affect the level of institutionalization of a program that deals a lot with outside agencies.

Contractor Assistance With Problems (Question 26). The aim of this question was to reword a previous question, reask it, and if the distributions of responses were the same, validate that question. As such, this question was a rewording of question 24.

The results of this question did not mimic that of the previous question. The DCMs and AGS Maintenance Supervisors both tallied medians of 4 with modes of 3. The AGS Maintenance Supervisors also had a dual mode of 4.

It should be noted that the AGS managers' modal values were not considered strong as their remaining responses were just one or two respondents behind. The EMS Maintenance Supervisors also showed a slightly similar distribution with their median of 3.5 and dual modes of 3 and 4. In the case of the CRS Maintenance Supervisors, they answered on the opposite side of the scale. Their median value was 4.5 with a strong mode of 6. Figure D.38 from Appendix D shows the modal response frequencies for this question. The  $H$  test was definitely required for this question. Despite the necessity for the statistical test, the low responses per scale value for the AGS and EMS Maintenance Supervisors caused the lack of the test's ability to conclude that two of the distributions were different. Shown in Table 4.5, the observed  $H$  value was below that of even the 95% confidence level test statistic, indicating the inability to reject the null hypothesis.

The results of the DCMs and partially of the AGS and EMS Maintenance Supervisors did somewhat validate the previous question's responses. The AGS and EMS Maintenance Supervisors responses were just shifted slightly to the left for this question. However, the CRS Maintenance Supervisors reversed their opinions. The cause for this difference could not be explained from this level of research. Further analysis of their attitudes concerning contractors should be investigated.

Questions 14, 20, 21, & 27: The maintenance indicators I input to the TAC Monthly Maintenance Summary are used to improve the R & M of my weapon system; I have adequate management tools to effectively manage R & M in my unit; If I support R & M, then my troops will support the



R & M program; R & M are "household" words in my unit. These last four questions were designed to tie all of the R & M tools together. They were asked to determine how the managers felt about the information they reported to higher headquarters, and overall whether they felt they had enough tools to manage the R & M 2000 program.

Monthly Maintenance Summary Inputs (Question 14). This question was primarily intended to find the extent that the maintenance managers felt their inputs to the TAC Monthly Maintenance Summary were used to improve the R & M of their weapon system. The responses were anticipated to be relatively high, as this was one of the few highly visible, already in place tools that could affect the R & M of any unit.

The distributions of responses did not entirely follow expectations. The DCMs had a median of 3.5 with a mode of 1. It should be also noted that 76.9% of their responses fell on the scale from a moderate to a very little extent. For the most part, the AGS, CRS, and EMS Maintenance Supervisors showed reversed response distributions. The Maintenance Supervisors all showed medians of 4. Their modes, however, indicated that their distributions were not exactly the same. The AGS Maintenance Supervisors had a mode of 5; the CRS Maintenance Supervisors had a mode of 3; and the EMS Maintenance Supervisors had a mode of 4. Because of these variations, the  $H$  test was necessary. At the 95% confidence level, the statistical test enabled the null hypothesis to be rejected. However, due to the relatively low response rates of the Maintenance Supervisors, the null hypothesis could not be rejected at the 99% confidence interval. The end result of the statistical test showed that two of the four distributions could

be considered different only at the lower confidence level. The response charts are included in Figure D.32.

With the exception of 12 respondents answering at the lowest scale value (16.2% of the sample), consensus was very nearly attained on this question. Overall, the tendency for responses was to the middle of the scale. This indicated that, as a whole, the maintenance managers felt their Monthly Maintenance Summary inputs were used neither moderately nor to a great extent to improve the R & M of their weapon system. This conclusion definitely calls for further research to find concrete reasons for the maintenance managers attitudes.

Availability of Adequate Management Tools to Effectively Manage R & M (Question 20). The underlying theme behind this question was to incorporate all of the previous more specific questions concerning the R & M tools available to maintenance managers into one question. It was designed to see how strongly the TAC managers felt that the tools that they believed they had were adequate to manage the R & M in their units. The responses were initially expected to fall at least in the moderately agree category. Based on the conclusions of many of the previous questions, the expectations were reevaluated, and predicted to fall in a slightly lower category.

The amended expectations were met. As per the medians, the responses nearly gained complete consensus. The median for the DCMs was 3.5, whereas all of the medians for the remaining categories carried the scale value of 4. However, the modes, shown in Figure 4.25 on the next page, indicated a slight disagreement amongst the DCMs and the CRS

Maintenance Supervisors. The DCMs' mode was 3 and the CRS Maintenance Supervisors' mode was 5. Neither mode was considered strong as the second highest responses for both of the categories was just one respondent away and on the other side of the scale. Both the AGS and EMS Maintenance Supervisors had modes of 4 that were relatively strong. The  $H$  test was required because of the actual modal differences between the DCMs and CRS Maintenance Supervisors. Table 4.5 shows the  $H$  test results. It concluded that the differences in the distributions were not strong enough to reject the null hypothesis for either confidence interval. Thus, at least three of the four distributions were viewed as being similar.

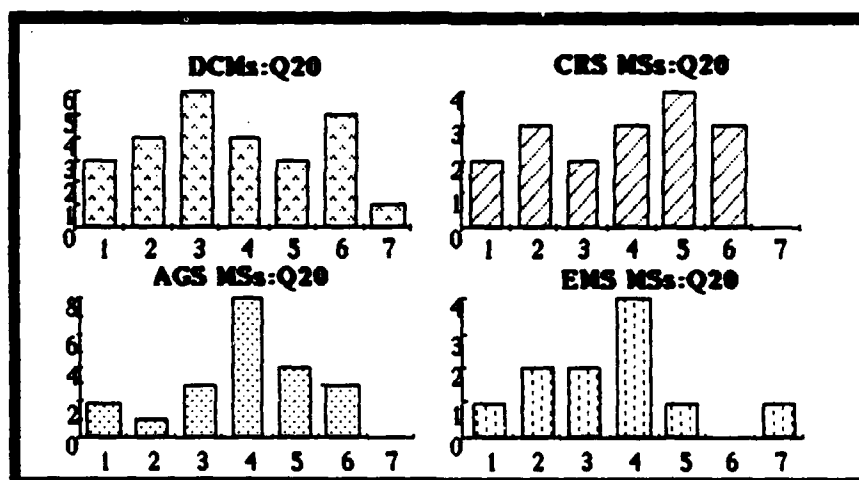


Figure 4.25. Section 3, Question 20 Survey Response Histograms

Notwithstanding the results of the  $H$  test, any conclusion for this question would be weak at best. The spread of the responses across the entire scale and the relatively weak modes indicated a general nonconsensus across the categories of maintenance managers. Overall, the managers neither agreed nor disagreed that they had adequate

management tools to effectively manage the R & M in their units. It would be interesting to find out if the results to this question would be different if the terms R & M were not included in the initial question, possibly determining the overall effectiveness of their management tools before the R & M 2000 program.

Personal Support of R & M Equated to Troop Support of R & M (Question 21). The design of this question was to finally determine an overall position of the maintenance managers concerning the support of the R & M 2000 program. The question was worded to state that if the maintenance managers supported the program, then it would follow that their troops would do the same. Therefore, this question tied into the concept of leadership and motivation, an overriding principle of the R & M 2000 process (see Figure 1.1).

The responses for this question were relatively high on the agree side of the response scale. The DCMs, AGS and CRS Maintenance Supervisors all showed medians of 6; the EMS Maintenance Supervisors showed a median of 5. The DCMs incurred dual modal values of 6 and 7. Both the AGS and CRS Maintenance Supervisors tallied modes of 6. The EMS Maintenance Supervisors' mode was slightly lower with a value of 5. This lower EMS mode caused the requirement of the  $H$  test. As only the EMS Maintenance Supervisors differed slightly from the remainder of the managers, it would follow that the statistical  $H$  test, aimed at detecting whether two or more of the distributions were different, would probably not have sufficient information to reject the null hypothesis. Table 4.5 shows this to be true and the distributions for this question were statistically viewed as being the

same. Figure D.36 shows the results for this twenty first question of this tools section.

A significant 86.3% of the respondents answered on the high side of the scale for this question. Almost 67% of the answers were in the top two scale values indicating moderate to strong agreement that their troops would support the R & M program if the maintenance managers did themselves. Overall, it could be stated that the managers believed that motivation was a key factor in making a program succeed. One must be careful not to overstate this conclusion in reference to this research. This question does not indicate whether the managers themselves felt motivated to support the program. This level of motivation could only be inferred from analyzing the other questions in this survey.

R & M As "Household" Words (Question 27). To wrap up the entire survey effort, this question was asked to find out the extent that the R & M terms were used in the TAC units. It was initially expected that the responses to this question would be highly skewed to the high side of the scale with the terms being used very often.

Expected results did not happen in this case. The DCMs answered with a median value of 5 and a mode of 6, indicating the terms were seldom used. The AGS, CRS, and EMS Maintenance Supervisors showed the same median value of 5, but their modes varied slightly. The AGS Maintenance Supervisors had a relatively weak mode of 6, whereas the CRS Maintenance Supervisors displayed dual modes of 3 and 5. Lastly, the EMS Maintenance Supervisors had dual modes of 3 and 7. The *H* test was necessary because of the wide spread of modal values. However, the spread was not sufficient

enough to statistically prove that two of the four distributions were different. The observed  $H$  value was below even the 95% test statistic indicating the failure to reject the null hypothesis. As a result, any conclusions drawn from this question were applicable to all of the manager categories. Figure 4.26 shows the response frequencies for each of this question's categories.

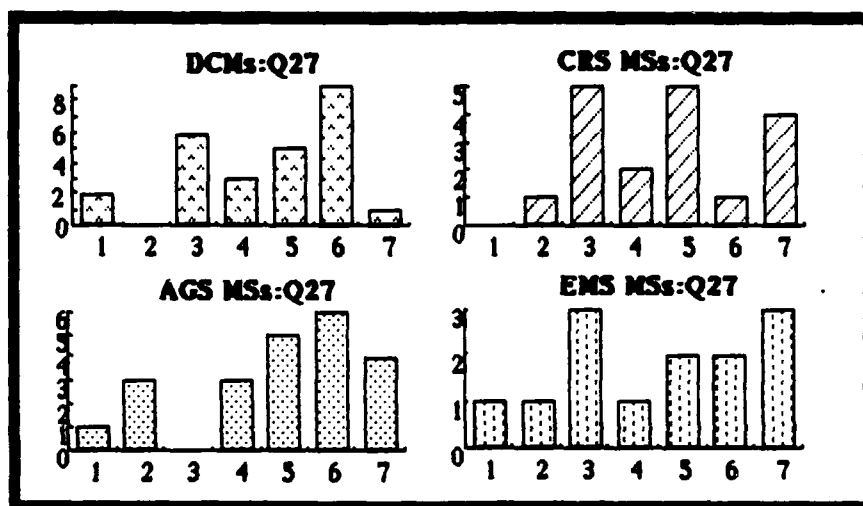


Figure 4.26. Section 3, Question 27 Survey Response Histograms

The results of this last question were not expected. It appeared as though an large number of respondents felt that these program terms were not common in their units. The large number of responses below the scale value of at least half the time indicated that generally the program appeared not to be institutionalized into their daily operations.

Overview of Section 3: Identification of Management Tools in the R & M 2000 Program. The previous twenty eight questions were all designed to draw out opinions and attitudes of TAC maintenance managers

concerning the degree or extent they used or understood the tools available for the management of the R & M 2000 program. For the most part, it appears as though the maintenance managers were using a majority of the tools available to monitor critical and common maintenance actions. The managers responded that the Quality Assurance program was used, that there were standard operating characteristics across similar subsystems, and that technical order changes were sought after to improve their understandability. However, clearly seen in this section of responses were the managers feelings that they did not have adequate tools to manage R & M in their organizations. The managers also felt that terms R & M were not "household words" in their units.

## **V. Conclusions and Recommendations**

### **Overview**

This chapter finalizes this research effort by proposing answers to the investigative questions posed in the first chapter. First, each section of the survey will be correlated to its motivating research question. Then, details concerning the observed institutionalization of the program will be evaluated and conclusions will be made concerning the institutionalization of the R & M 2000 program in general. Finally, recommendations for future research will be presented in hopes of encouraging continuing studies involving R & M management concerns.

### **R & M 2000 Implementation in TAC**

The implementation of a program can be paramount to its success. The actual processes of implementation may vary, but emphasis should always be placed on understanding the goals of that program. To this end, the institutionalization of the goals of a program becomes very critical; if the subordinates do not know what to do and why, then the program will be destined to failure.

The first section of the survey instrument used in this research effort was designed to answer the first investigative question: How is the R & M 2000 program being implemented in TAC maintenance organizations? It questioned TAC maintenance managers concerning the goals of the program and the levels of motivation those managers may have



used in implementing the goals. Managers were questioned because they play a key role in motivating subordinates, and as such, are essential factors in the overall institutionalization process. How the managers plan, organize, and control their daily operations plays a large part in determining the extent that a program is implemented and institutionalized in any organization.

The in-depth analysis of the questions from the first section of the survey led to conclusions concerning the implementation of the R & M 2000 program. With the exception of only four cases, at the 99% confidence level, at least three of the four maintenance manager categories were considered to have the same response distributions. Therefore, any conclusions could be generalized to at least three quarters of the TAC maintenance managers population.

The TAC managers felt they were involved in the daily operations of their units to at least a fairly large extent. All of the questions dealing with involvement in management decisions showed positive results. However, if the term R & M was included in the question, the results were not the same. With the addition of the R & M terms, the responses tended to the lower and negative sides of the scales. It should also be noted that the responses usually ranged very low for these types of questions. TAC managers, as a whole, did not feel that their weapon systems demanded their involvement in R & M decisions.

These interesting non-involvement results were also observed in the evaluation of the respondents' extent of commitment in managing the R & M 2000 program goals. At all of Levy's change levels, the only goal that the managers felt they had control over was the first goal addressing

combat capability. At the "mission" level, it did not appear that any of the maintenance managers had any significant extent of involvement in the last four goals of the R & M 2000 program. Even the managers' responses to the lower dimensional questions concerning the "culture" level did not appear to show involvement with R & M actions.

However, at the "core processes" dimension, the managers' commonly showed positive results as opposed to the higher dimension questions' negative results. When questioned concerning the extent that TAC managers tracked critical maintenance actions to ensure that they did not adversely affect the unit's mission, a significant majority of the maintenance managers responded strongly using the "to a very great extent" response. In addition, the managers indicated that they tracked the common maintenance actions to a fairly large extent if those actions might possibly affect the unit's mission.

The first section of the survey also queried the maintenance managers concerning the motivation of their subordinates. Ultimately, managers know they must motivate, regardless of the construct they motivate towards. In this case, the TAC maintenance managers felt that motivating their troops was essential in institutionalizing the R & M 2000 program. Hence, what was most likely measured by this first survey section was a degree of managerial reaction to motivation, specifically attuned to the R & M 2000 program. When specifically asked of the extent to which they actually encouraged their subordinates to practice the program precepts, the managers responded positively. This seemed to conflict with the previous results that the maintenance managers did not get involved with the R & M process. Future research must try to uncover possible reasons

for the differences between the managers' feelings concerning their degree of R & M encouragement and their overall level of R & M involvement. General conclusions as to what these interim results indicate concerning the overall level of institutionalization of the R & M 2000 program will be discussed later.

### R & M 2000 Education and Training in TAC

Education is always an important aspect of any program. Without education, there could be a lack of understanding about the reasons why a program is being initially set up, as well as a lack of understanding of that program's objectives or goals. Training is also included under the umbrella of education. In the developmental stages of a program, training is essential to make people aware of the new program itself. In the continuing stages of a program, training is essential to keep people cognizant of the progress of the program and to educate people on any program alterations that may arise. Ultimately, training affects the "culture" dimension of Levy's second order change model. As in the case of the previous implementation process, managers are the keys to successful education and training programs. As a result of manager-encouraged use of training programs, organizations become more informed concerning the precepts of any particular program.

The second section of this research effort's survey instrument intended to determine the extent of R & M 2000 education that was present in the Tactical Air Command environment. It questioned TAC maintenance managers concerning the methods by which they were trained in the

concepts of R & M. It also was developed to find out if they felt it was important to have sufficient training programs for subordinates.

The critical issue in this section of the survey was the depth of training that the majority of maintenance managers possessed. The R & M education could have been acquired through formal training or by learning vicariously about the program through daily experiences. A high number of managers indicated they had not been formally trained, and of those who were trained, most of the training was gained from previous jobs dealing with AFSC and AFLC programs. Nevertheless, whenever questions were asked concerning the importance of training and education, the responses were strongly positive. However, whenever questions were asked if any training programs were in place, the answers were strongly negative. It appeared that although the managers felt education was absolutely necessary, they had not undertaken the responsibility to see that any training programs were established. Therefore, it could be seen that, in the field, it did not appear as though any training programs were available to educate TAC personnel on the precepts of the R & M 2000 program.

It is important to note that all of the managers agreed that training was essential in establishing any program during its initial phases. However, since no formal training was conducted, a question then arose as to whether the self-taught experiences of the TAC maintenance managers were sufficient to institutionalize the R & M 2000 program across the command. Levy's model did not address any differences between the level of institutionalization gained via self-taught experiences versus formal training. As such, this research could not resolve this issue; further research

may provide reasons for differences between formal and self-taught education, and possible relationships with the institutionalization process.

An additional aim of the education and training section of the survey instrument was to determine whether the maintenance managers knew how to accomplish the requirements of the R & M 2000 program. From the survey results, it could be determined that the TAC DCMs and Maintenance Supervisors felt that they only knew how to compute or improve R & M factors to a little extent. Additionally, many of the managers indicated that their efforts to improve the R & M factors in their units were slight. The maintenance managers also responded that their subordinates were not trained in R & M policies concerning the R & M factors. Hence, it could be seen that the maintenance managers did not appear to be aware of how to accomplish the requirements of the R & M 2000 program. Again, overall conclusions, with respect to the impact of the education and training level on the degree of institutionalization of the program, will be discussed later.

#### R & M 2000 Tools Identification and Use in TAC

In almost any program, tools are needed to measure the success of the program goals. Organizations must be aware of and use the tools in order to incorporate any program changes into their daily operations. The tools may demand new actions or simply require restatements or readjustments of the current ways of accomplishing actions. Awareness and management involvement are the key factors in making any changes happen smoothly. The identification and use of specific tools opens the door to the "core processes" of Levy's change model.

In the case of the R & M 2000 program, many of the tools used to measure the success of the program were already in use. However, when queried as to whether the maintenance managers knew and used the specific R & M tools that were at their disposal for their use in managing the R & M 2000 program, a majority of the managers only knew of the tools to a little extent. When asked about specific R & M terms, a significant number of managers were ignorant of their definitions. "Double R/Half M" was a prime example where many managers even wrote comments on the survey explaining their lack of knowledge of the term.

Despite the apparent lack of understanding of the tools available for managing R & M, there did appear to be a largely positive response tendency for many of the remaining tools questions in this section of the survey. Maintenance managers did use Quality Assurance to monitor reliability and maintainability aspects of their units. Managers did use PIWGs when they could. Managers did ensure there were standard operating and testing characteristics across subsystems in their weapon systems. Still further, managers did process technical order changes to improve troubleshooting and repair procedures. They also generally monitored the MTBFs of their avionics systems to ensure they matched expectations. They processes failed units through warranty programs. The list of tools that they did use goes on and on. The only differences between managers seemed to be the extent to which they used some of the tools, still keeping in mind that generally all of the responses were on the positive sides of the response scales. What appears to be the case is the fact that the managers were not aware that the same tools they used in their daily operations could be used to manage the R & M goals. The "core processes"

were already there, they just did not know that they applied to the precepts of R & M 2000. Therefore, what seemed to be found was that even though TAC maintenance managers are good managers, R & M is not a part of their overall knowledge structure. Tying together the results of the R & M 2000 program implementation, the level of R & M education and training, and the use of R & M tools allows conclusions to be made concerning the overall institutionalization of the R & M 2000 program in the Tactical Air Command.

#### Overall Institutionalization of the R & M 2000 Program

Levy's model involving the "paradigm" to "core process" levels was used in this research effort to describe the extent of institutionalization in the Tactical Air Command environment. The overall level of paradigmatic change was to be found only after Levy's lower dimensions were evaluated. First, the implementation of the R & M 2000 program was looked at as the "mission" dimension, including specifics about how managers plan, organize, and control their organizations. Second, training was viewed at the "culture" level, to determine if the managers functioned with changed thought processes when dealing with R & M 2000 program actions. Lastly, tools were evaluated to quantify the "core processes" dimension. Throughout each dimension, other levels were intertwined and analyzed to give depth to each dimension. By this it is meant that while analyzing the first survey section, designed primarily to draw out information concerning the "mission" level, more specific details involving deeper "culture" and "core processes" were also analyzed. Additionally, while evaluating the

training or "culture" level, the "mission" and "core processes" attributes were still investigated. As each lower level was analyzed, Levy's "paradigm" level was being assessed to determine the cumulative extent of institutionalization of the R & M 2000 program in TAC maintenance managers.

The level of institutionalization of each dimension below the "paradigm" must be discussed first, before the cumulative results of the "paradigm" level could be detailed. From the first investigative question's results, it was determined that the overall institutionalization of the program at the "mission" or implementation stage was low. Even though the desire to manage critical maintenance actions was evident, involvement in the implementation of the R & M 2000 program was not demonstrated.

From the second investigative question's results, it was found that the institutionalization of the program at the "culture" or training dimension was very low. Although training was deemed as essential to the program, very few programs were developed to educate any personnel in TAC. R & M training appeared to be accomplished outside of the command and filtered into the command by managers vicariously learning as they tried to manage the program.

From the third investigative question's results, it was found that the institutionalization of the program at the "core process" level was relatively high. A common trend, however, was that the maintenance managers did not appear to be always aware that the maintenance management actions that they were accomplishing were actually R & M program management tools.



The focus of this study could finally be directed at the concept of institutionalization at the "paradigm" level. Since the "mission" and "culture" dimensions did not appear to be institutionalized, the "paradigm" level could not be institutionalized either. The nested nature of the model provides the justification for this conclusion. If the dimensions below have not changed, the higher dimension cannot yet be institutionalized. The TAC managers in general did not seem to have a good perspective on the 'whole picture' or "underlying assumptions that unnoticeably shape perceptions, procedures, and behaviors" (16:17). Even though the "core processes" looked as though they were being accomplished, the managers did not view the R & M 2000 program as part of their everyday life. As previously stated, the terms R & M were not viewed as common 'household' words in most maintenance organizations. The job of accomplishing the requirements of the program seemed to be getting done, just a deeper understanding of the underlying precepts of the R & M 2000 seemed to be missing.

Nevertheless, commitment to change takes time. Because the "paradigm," "mission," and "culture" dimensions of Levy's model did not appear to be institutionalized for the R & M 2000 program, this did not necessarily mean that the institutionalization process was not currently taking place. It could possibly be concluded that the first steps were occurring because of the "core processes" that were being accomplished. The *refreezing* step, identified as stabilizing a change by sustaining the new state, could be viewed as currently in progress. In sustaining the new state, the unnoticeable changes in perceptions are taking hold and R & M can finally become part of TAC's everyday maintenance management. Time, then, plays an important part in seeing how fast this final "paradigm"

level change finally takes root in the field. Care must be taken not to disturb and shift the emphasis away from R & M, else the *refreezing* of the precepts and the final movement to the "paradigm" dimension could be hindered.

Despite the indication of the initial stages of institutionalization, is the R & M 2000 program doomed to never progress to the final "paradigm" level? Brigadier General Robert P. McCoy, the HQ AFLC Command Assistant for R & M, stated it best.

The largest problem ... is getting people to acknowledge the "ultimatum" nature of Air Force R & M 2000. Many skeptics are pondering the question, "Why this time when many previous efforts floundered?" The answer ... is very simple. We are saddled with a force structure and support infrastructure that we have inherited from the realities of a different era, one where sanctuary and an abundance of people were given. The world is not the same and we must react to that reality now [20:176].

General McCoy's comments indicate that with the new constraints today, new programs need to increase capabilities, while still reducing manpower, mobility, and cost requirements; the R & M 2000 program accomplishes just that. Therefore, the R & M 2000 program is destined to succeed and given enough time, will be fully institutionalized to the highest level.

#### Recommendations for Future Research

The umbrella which covers this R & M 2000 project could provide many additional areas for future research. Other Air Force commands could be analyzed to determine if the extent of institutionalization is different from organization to organization. The commands could be evaluated both now

and in the future, possibly in five years, to see if the institutionalization of the program has progressed to the paradigm level.

Still further, other managers both in TAC and in other commands could be the target of additional research. In TAC, the opinions and attitudes of the Aircraft Maintenance Unit or other squadron branch chiefs could be evaluated. Even, shop or flight chiefs could be the object of future research. Correlations between the results at any level could also be the topic of a specific study.

Finally, throughout this research effort, inconclusive or unexplainable results were obtained which could blossom into future research endeavors.

**Appendix A: Listing of Tactical Air Command**  
**Addresses**

Surveys were mailed to the assigned Deputy Commanders for Maintenance, AGS, CRS, and EMS Maintenance Supervisors for the following units.

1st	Tactical Fighter Wing	Langley AFB VA
4th	Tactical Fighter Wing	Seymour Johnson AFB NC
23rd	Tactical Fighter Wing	England AFB LA
27th	Tactical Fighter Wing	Cannon AFB NM
31st	Tactical Fighter Wing	Homestead AFB FL
33rd	Tactical Fighter Wing	Eglin AFB FL
35th	Tactical Training Wing	George AFB CA
37th	Tactical Fighter Wing	George AFB CA
49th	Tactical Fighter Wing	Holloman AFB NM
56th	Tactical Training Wing	Macdill AFB FL
57th	Fighter Weapons Wing	Nellis AFB NV
58th	Tactical Training Wing	Luke AFB AZ
67th	Tactical Reconnaissance Wing	Bergstrom AFB TX
325th	Tactical Training Wing	Tyndall AFB FL
347th	Tactical Fighter Wing	Moody AFB GA
354th	Tactical Fighter Wing	Myrtle Beach AFB SC
355th	Tactical Training Wing	Davis Monthan AFB AZ
363rd	Tactical Fighter Wing	Shaw AFB SC
366th	Tactical Fighter Wing	Mountain Home AFB ID
388th	Tactical Fighter Wing	Hill AFB UT
405th	Tactical Training Wing	Luke AFB AZ
474th	Tactical Fighter Wing	Nellis AFB NV
4450th	Tactical Group	Nellis AFB NV

Surveys were mailed to the assigned Deputy Commanders for Maintenance or Chiefs of Maintenance, AGB, CRB, and EMB Maintenance Branch Chiefs for the following units. Some units did not have all managers assigned.

48th	Fighter Interceptor Squadron	Langley AFB VA
49th	Fighter Interceptor Squadron (unit deactivated after survey mailed)	Griffiss AFB NY
57th	Fighter Interceptor Squadron	FPO NY 09673
318th	Fighter Interceptor Squadron	McChord AFB WA
23rd	Consolidated Aircraft Maintenance Squadron	Davis Monthan AFB AZ
24th	Consolidated Aircraft Maintenance Squadron	Howard AFB PN
27th	Consolidated Aircraft Maintenance Squadron	George AFB CA
549th	Consolidated Aircraft Maintenance Squadron	Patrick AFB FL
4507th	Consolidated Aircraft Maintenance Squadron	Shaw AFB SC
41st	Electronic Combat Squadron	Davis Monthan AFB AZ
431st	Test & Evaluation Squadron	McClellan AFB CA
552nd	Airborne Warning & Control Wing	Tinker AFB OK
960th	Airborne Warning & Control Squadron	FPO NY 09571
961st	Airborne Warning & Control Squadron	APO SF 96239
962nd	Airborne Warning & Control Squadron	Elmendorf AFB AK
4460th	Helicopter Squadron (unit deactivated after survey mailed)	Indian Springs AAF NV

## Appendix B: R & M Management Survey Questionnaire



### DEPARTMENT OF THE AIR FORCE

HEADQUARTERS TACTICAL AIR COMMAND  
LANGLEY AIR FORCE BASE VA 22665-5001

REPLY TO  
ATTN OF LGM

23 APR 1988

SUBJECT R&M 2000 Management Survey

TAC Deputy Commanders for Maintenance and Squadron Maintenance  
Supervisors (USAF Survey Control No. 88-55(Expires 31 Jul 88))

1. In February 1985, the Secretary and Chief of Staff of the Air Force issued a joint memorandum renewing the Air Force commitment to reliability and maintainability (R&M) which came to be called the R&M 2000 program. Since that time, many changes designed to deliver more reliable and maintainable equipment and improve our fielded systems have occurred in the way we do business. To date, no specific management studies have been conducted to determine our success in spreading the word to the field unit level. Therefore, we are pleased to sponsor the thesis research effort of Capt Jim Silva, AFIT/LSM, who is pursuing his Master's degree in logistics management.

2. As a Deputy Commander for Maintenance or Maintenance Supervisor, your answers to the attached questionnaire will give us a good indication of how R&M 2000 is being accepted and "institutionalized" in the field. We realize that a major portion of the R&M 2000 policies apply to AFLC and AFSC, but we want to know to what degree the R&M 2000 program is being felt in the field.

3. All responses will be treated as confidential, and there will be no attribution to specific individuals in the final report.

4. Your participation in this research endeavor is voluntary, but your experience and knowledge of flightline operations would greatly enhance the validity of this report. I encourage you to respond. For further information, please contact Maj Skip Collins, TAC/SMO-R&M (AV 574-2542) or Maj Robert E. Trempe, AFIT/LSM (AV 784-4149).

RICHARD M. HIGBIE, Colonel, USAF  
Director of Maintenance Engineering

- 2 Atch
- 1. Questionnaire
- 2. Return Envelope

*Readiness is our Profession*

### NOTES FOR RESPONDENTS

The primary addressee is encouraged to complete this questionnaire.

However, Deputy Commanders for Maintenance may option to have their assistant Deputy Commanders for Maintenance complete this questionnaire.

Squadron Maintenance Supervisors may also option to have their assistants complete this questionnaire.

\*Maintenance Superintendents are not included in this category.\*

### INSTRUCTIONS FOR ANSWERING QUESTIONNAIRE

*The statements on this questionnaire deal with the characteristics of your job and your attitude. For some jobs, certain statements may not be applicable. Should this be the case, then you should not answer any of the responses and leave the question blank. Indicate your responses by circling the answer which best represents your views or experiences.*

ALL RESPONSES CONTAINED WILL BE CONFIDENTIAL. PLEASE DO NOT PROVIDE ANY OTHER DEMOGRAPHICS THAN THOSE REQUESTED.

## PERSONAL DATA

1. What is your present grade?
  - a. Captain or below
  - b. Major
  - c. Lieutenant Colonel
  - d. Colonel
2. What position do you currently hold?
  - a. AGS Maintenance Supervisor
  - b. CRS Maintenance Supervisor
  - c. EMS Maintenance Supervisor
  - d. CAMS Maintenance Supervisor
  - e. Assistant Deputy Commander for Maintenance
  - f. Deputy Commander for Maintenance
  - g. Other (please specify) \_\_\_\_\_
3. How long have you been in your present position?  
\_\_\_\_\_YEARS \_\_\_\_\_MONTHS
4. How long have you been in the maintenance career field?  
\_\_\_\_\_YEARS \_\_\_\_\_MONTHS
5. How long have you been in TAC?  
\_\_\_\_\_YEARS \_\_\_\_\_MONTHS
6. On what type of weapon system do you work?
  - a. A-7
  - c. F-4
  - e. F-15
  - g. F-111
  - b. A-10
  - d. F-5
  - f. F-16
  - h. Other (please specify) \_\_\_\_\_
7. In what regional area is your base located?
  - a. 9th AF
  - b. 12th AF
  - c. Other (please specify) \_\_\_\_\_
8. What is the primary mission of your weapon system?
  - a. Training
  - b. Test
  - c. Operational
  - d. Other (please specify) \_\_\_\_\_
9. Have you been formally trained on the concepts of R & M 2000?
  - a. No
  - b. Yes: Where?
    - (1) AFIT PCE course
    - (2) Local military course
    - (3) Academic University course
    - (4) Other (please specify) \_\_\_\_\_



## **SECTION 1**

1. Below are questions which relate to your attitudes, beliefs, and your job. Read each question carefully and then decide to what extent the answer is true of your situation. Using the scale below to best represent your feelings, indicate the extent that the answer is true by circling the number to the right of the question.

- |                                      |                             |
|--------------------------------------|-----------------------------|
| 1. To a very little extent           | 5. To a fairly large extent |
| 2. To a little extent                | 6. To a great extent        |
| 3. To a moderate extent              | 7. To a very great extent   |
| 4. Neither moderate nor great extent |                             |

- |   |          |          |          |          |          |          |          |
|---|----------|----------|----------|----------|----------|----------|----------|
| 1. I get involved in the R & M process.   | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 2. I plan the daily operations in my unit.  | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 3. I organize the daily operations in my unit.  | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 4. I control the daily operations in my unit.   | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 5. My job provides freedom and independence in selecting my own procedures to accomplish my work. | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 6. I am aware of the guidelines of the R & M 2000 Program.  | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 7. My weapon system demands my involvement in R & M decisions.                                    | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 8. I actually get involved with R & M decisions.  | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 9. I have control/get involved with increasing the combat capability of my unit.                  | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |

1. To a very little extent

2. To a little extent

3. To a moderate extent

4. Neither moderate nor great extent

5. To a fairly large extent

6. To a great extent

7. To a very great extent

- |   |          |          |          |          |          |          |          |
|---|----------|----------|----------|----------|----------|----------|----------|
| 10. I have control over increasing the survivability of my weapon system.   | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 11. I have control/get involved with decreasing the mobility requirements for my unit.                              | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 12. I get involved setting manpower requirements for my unit.   | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 13. I have free rein to adjust shop/section size to better meet the needs of my unit.                               | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 14. I <i>actually</i> review and adjust, on a frequent basis, the manning and skill level requirements for my unit. | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 15. I have control over decreasing R & M costs.   | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 16. I <i>actually</i> control the O & M budget in my unit.  | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 17. I frequently brief my personnel on the importance of the R & M policies.  | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 18. I track <i>critical</i> maintenance actions to ensure that they do not adversely affect my unit's mission.      | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 19. I track <i>common</i> maintenance actions to ensure that they do not adversely affect my unit's mission.        | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |

Below are statements which relate to your attitudes, beliefs, and your job. Read each statement carefully and then indicate your level of agreement/disagreement. Using the scale below to best represent your feelings, indicate the level that you agree/disagree by circling the number to the right of the statement.

- |                               |                     |
|-------------------------------|---------------------|
| 1. Strongly disagree          | 5. Slightly agree   |
| 2. Moderately disagree        | 6. Moderately agree |
| 3. Slightly disagree          | 7. Strongly agree   |
| 4. Neither disagree nor agree |                     |

- |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|
| 20. Survivability is an important R & M goal in peacetime operations.                       | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 21. I impact the R & M costs in my unit.  | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 22. I do my job differently now as opposed to before the R & M 2000 Program was instituted. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 23. I encourage my subordinates to practice R & M policies.                                 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 24. R & M is the responsibility of someone else.  | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 25. Motivation of my troops is essential in institutionalizing the R & M 2000 Program.      | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 26. My inputs into the R & M process actually affect decisions at other levels.             | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 27. R & M is the primary responsibility of AF Systems or Logistics Command.                 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 28. My effort in promoting R & M is greater than that of my coworkers.                      | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

## **SECTION 2**

**2. Below are statements which relate to your attitudes, beliefs, and your job. Read each statement carefully and then indicate your level of agreement/disagreement. Using the scale below to best represent your feelings, indicate the level that you agree/disagree by circling the number to the right of the statement.**

- |                               |                     |
|-------------------------------|---------------------|
| 1. Strongly disagree          | 5. Slightly agree   |
| 2. Moderately disagree        | 6. Moderately agree |
| 3. Slightly disagree          | 7. Strongly agree   |
| 4. Neither disagree nor agree |                     |

- |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|
| 1. Training is essential in establishing any program during its initial phases.                             | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2. It is necessary to have a formal course established to teach R & M concepts.                             | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 3. I have been educated in the ways of R & M through my own daily experiences.                              | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 4. Through my own experiences, I have sufficiently trained myself concerning R & M 2000 Program management. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 5. My subordinates understand what reliability means.   | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 6. My subordinates understand what maintainability means.   | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 7. The next higher level of management is interested in R & M practices.                                    | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8. AFSC understands what R & M means.   | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 9. AFLC understands what R & M means.   | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

1. Strongly disagree
2. Moderately disagree
3. Slightly disagree
4. Neither disagree nor agree

5. Slightly agree
6. Moderately agree
7. Strongly agree

10. My organization has instituted sufficient training programs for R & M. *1 2 3 4 5 6 7*
11. R & M education and training in my unit primarily emphasizes the weapon system itself. *1 2 3 4 5 6 7*
12. My R & M education and training program addresses support equipment and supply items as well as the aircraft in my unit. *1 2 3 4 5 6 7*
13. My R & M experience has been gained primarily by "learning as I go." *1 2 3 4 5 6 7*
14. R & M is more important in newer weapon systems. *1 2 3 4 5 6 7*
15. "Blue Two" Visits are helpful for the contractor, AFSC, or AFLC to determine my specific R & M needs. *1 2 3 4 5 6 7*
16. My unit has frequent "Blue Two" Visits. *1 2 3 4 5 6 7*

Below are questions which relate to your attitudes, beliefs, and your job.  
Read each question carefully and then decide to what extent the answer is  
true of your situation. Using the scale below to best represent your  
feelings, indicate the extent that the answer is true by circling the number  
to the right of the question.

- |                                      |                             |
|--------------------------------------|-----------------------------|
| 1. To a very little extent           | 5. To a fairly large extent |
| 2. To a little extent                | 6. To a great extent        |
| 3. To a moderate extent              | 7. To a very great extent   |
| 4. Neither moderate nor great extent |                             |

- |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|
| 17. I understand how to compute R & M factors.                            | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 18. I understand how to improve R & M factors.                            | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 19. My efforts improve R & M factors within my unit.                      | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 20. I know how many spaces per aircraft my unit is authorized.            | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 21. My subordinates have been trained in the R & M 2000 Program policies. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

### SECTION 3

3. Below are questions which relate to your attitudes, beliefs, and your job. Read each question carefully and then decide to what extent the answer is true of your situation. Using the scale below to best represent your feelings, indicate the extent that the answer is true by circling the number to the right of the question.

- |                                      |                             |
|--------------------------------------|-----------------------------|
| 1. To a very little extent           | 5. To a fairly large extent |
| 2. To a little extent                | 6. To a great extent        |
| 3. To a moderate extent              | 7. To a very great extent   |
| 4. Neither moderate nor great extent |                             |

- |  |          |          |          |          |          |          |          |
|--|----------|----------|----------|----------|----------|----------|----------|
| 1. I know what tools are at my disposal for measuring R & M in my unit.  | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 2. I use the tools at my disposal for R & M management.  | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 3. I have the time to use the tools necessary for improving R & M.   | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 4. I use Quality Assurance for checking on aspects of R & M in my unit.  | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 5. PIWGs have an impact on improving R & M in my unit.   | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 6. I know the meaning of "Double R/ Half M".   | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 7. I know what the minimum specifications for mean time between failure (MTBF) are for the avionics units in my weapon system. | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |

- |                                      |                             |
|--------------------------------------|-----------------------------|
| 1. To a very little extent           | 5. To a fairly large extent |
| 2. To a little extent                | 6. To a great extent        |
| 3. To a moderate extent              | 7. To a very great extent   |
| 4. Neither moderate nor great extent |                             |

- |  |          |          |          |          |          |          |          |
|--|----------|----------|----------|----------|----------|----------|----------|
| 8. In my weapon system, there are standard operating, maintenance, and testing characteristics across similar subsystems.  | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 9. Repeatable fault isolation indications show up in the lowest possible field replaceable modules.  | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 10. I have initiated a warrantied tool program.  | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 11. I use the Suggestion Program to get modifications incorporated into a unit.  | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 12. The maintenance and test equipment requirements for new parts or improvements with my weapon system are compatible with existing equipment.                    | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 13. Technical data changes to improve the understandability of troubleshooting and repair techniques are readily accepted through technical order change channels. | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |
| 14. The maintenance indicators I input to the TAC Monthly Maintenance Summary are used to improve the R & M of my weapon system.                                   | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> | <i>6</i> | <i>7</i> |



Below are statements which relate to your attitudes, beliefs, and your job.  
Read each statement carefully and then indicate your level of agreement/  
disagreement. Using the scale below to best represent your feelings,  
indicate the level that you agree/disagree by circling the number to the  
right of the statement.

1. Strongly disagree
2. Moderately disagree
3. Slightly disagree
4. Neither disagree nor agree

5. Slightly agree
6. Moderately agree
7. Strongly agree

15. MTBFs for most of the avionics in my weapon system are realistic.     1   2   3   4   5   6   7
16. If a unit fails to meet its warranty, I have the ability to process the return of that unit.     1   2   3   4   5   6   7
17. "Blue Two" Visits are an effective part of managing how the contractor, AFSC, or AFLC sees the defects of particular items in my unit.     1   2   3   4   5   6   7
18. If I find a better way to access a unit in my weapon system, my inputs will be "heard" and taken into consideration.     1   2   3   4   5   6   7
19. In the case of new modifications, the preventive maintenance schedules are realistic.     1   2   3   4   5   6   7
20. I have adequate management tools to effectively manage R & M in my unit.     1   2   3   4   5   6   7
21. If I support R & M, then my troops will support the R & M program.     1   2   3   4   5   6   7

Below are statements which relate to your attitudes, beliefs, and your job.  
Read each statement carefully and then decide how often the statement is  
true in your situation. Using the scale below to best represent your  
feelings, indicate the frequency that the statement occurs by circling the  
number to the right of the statement.

- |                            |                 |
|----------------------------|-----------------|
| 1. All of the time         | 5. Occasionally |
| 2. Most of the time        | 6. Seldom       |
| 3. A good deal of the time | 7. Never        |
| 4. About half of the time  |                 |

22. I attend Product Improvement Working Groups (PIWGs) as they are held for my weapon system.    *1   2   3   4   5   6   7*
23. My unit processes an inordinate number of Quality Deficiency Reports.    *1   2   3   4   5   6   7*
24. Hardware and software anomalies in my unit are reported to the contractor, AFSC, or AFLC then solved (as opposed to solving them at my level and then reporting the corrective action).    *1   2   3   4   5   6   7*
25. Production drawings for new items in my unit are readily available.    *1   2   3   4   5   6   7*
26. In the case of new modifications or equipment improvements, the contractor is readily available to assist with problems.    *1   2   3   4   5   6   7*
27. R & M are "household words" in my unit.    *1   2   3   4   5   6   7*
28. "Double R/Half M" is an attainable goal.    *1   2   3   4   5   6   7*

#### **END OF QUESTIONNAIRE**

**Please seal this survey questionnaire in the accompanying envelope and return it no later than 27 May 1988.**

**•Thank you for your assistance in completing this survey.•**

**Appendix C: Survey Median/Mode Response  
Comparison Tables**

**Table C.1. Section 1  
MEDIAN & MODE RESPONSE COMPARISONS**

Sect. 1 #	DCMs		AGS MSs		CRS MSs		EMS MSs	
	medians	modes	medians	modes	medians	modes	medians	modes
1	5	6	2	1	3	1	2	1
2	5	3/5	5	5	5	5	3.5	3/5
3	4.5	3/5	5	5	4	2/3/5	4	3
4	5	5	5	5	5	6	5	5
5	5	5	5	5	5	5	5	5
6	4.5	4/5	4	1/5	3	2	2	1
7	4	6	3	1	4	1/5	4	1/4
8	4	6	1	1	2	1	3	1
9	6	6	5	5	5.5	5/6	5	5
10	3.5	1	3	1/2	2.5	2	3.5	2
11	3.5	1	3	1	3	1	4	4
12	5	6	4	3	3	3	5	5
13	3	3	4	2/3/4/7	4	5	2	2
14	4	3/5/6	4	2	3	2	3	3
15	2	1	2	1	2	1/2	2	1
16	5	6	2	1	3	3	2	1
17	3.5	6	1	1	3	1	2	1
18	7	7	6	6/7	6	6	6.5	7
19	5	3/5/6/7	6	6	5	5	5	5
20	6.5	7	6	7	6	7	6	7
21	5	4/5	4	4	5	5	4	5/-
22	3	2	2	1	4	4	3.5	4
23	6	6	4.5	5	5	4/5	5	7
24	1	1	2	1	2	1	2	2
25	6	7	6	7	5	4/5/6	4	4
26	5	5	4	4	4.5	6	4.5	6
27	3	1	4.5	2	4	5	4	1
28	4	4	4	4	4	4	4	4/-

**Table C.2. Section 2  
MEDIAN & MODE RESPONSE COMPARISONS**

Sect. 2 #	DCMs		AGS MSs		CRS MSs		EMS MSs	
	medians	modes	medians	modes	medians	modes	medians	modes
1	7	7	7	7	7	7	7	7
2	5	5	6	6	5	6	5	5
3	6	6	5	5	5	5	5	5
4	3	3	3	1 1/2 3	3	3	2	2
5	6	6	5	5	6	6	5.5	7
6	6	6	6	5 7	5	5	5.5	7
7	4	6 7	5	5	6	5 6 7	7	7
8	4	4	6	6	5	4	4	4
9	5	4 7	6	6	5	6	4	4
10	3	3	2	1	3	3	2	1 1/2
11	5	5	4	4	4	4 5	4	1 1/4
12	5	6	4	4	4	4 1-	2	2
13	6	6	5	5 6	5	5 1-	6	7
14	3.5	7	4	1	5	5 7	4.5	6
15	6	7	5	4	5	5 6 1-	5	4 1-
16	3.5	1	4	1	4	1 1/2 4	2	1
17	1	1	1	1	1	1	1	1
18	3	1	3	1	3	1 1/3	2	1
19	4	2	4	4	3	1 1/5	2.5	1
20	6	7	4	7	3	1 1-	1.5	1 1-
21	1.5	1	1	1	2	1	1	1

**Table C.3. Section 3  
MEDIAN & MODE RESPONSE COMPARISONS**

Sect. 3 ?*	DCMs		AGS MSs		CRS MSs		EMS MSs	
	medians	modes	medians	modes	medians	modes	medians	modes
1	3	1	1	1	2	1	2	1
2	4	1	2	1	2	1	1.5	1
3	4	4	2	1	2	1	3	4
4	5	5/6	4	5/-	4	5	4	5
5	5.5	6	5	5	5	5	4	4
6	1	1	4	1	1	1	3	1/-
7	3	1	5	6/-	3	3	1	1
8	4	4/5	5	5	5	5/-	5	6/-
9	3	3/4	4	4/5/-	4	4/-	4	4/-
10	2	1	3	1/-	2	1	4	1/2/5/-
11	5	5	4	1	5	3/5	6	7
12	3.5	3	5	5	4.5	5	5	5/-
13	3	3	5	1/6	5	6	5.5	7
14	3.5	1	4	5	4	3/-	4	4/-
15	3.5	3/5	5	5	4	3	4	4/-
16	5	7	5	5/6/-	6	6	6	4/6/-
17	6	6	4	4	5	5/-	4	4/-
18	5	5	5	6	5	6/-	5	4/-
19	4	4	5	5/-	5	5/6	5	5/-
20	3.5	3	4	4/-	4	5	4	4/-
21	6	6/7	6	6	6	6	5	5
22	5	6/7	7	7	7	7	7	7
23	4.5	3/5/6	4	5	5	5/6	5.5	6
24	3.5	2	4	4/5/-	4	2	4	3/6/-
25	5	5	5	4	4.5	3/5/6	3	3
26	4	3	4	3/4	4.5	6	3.5	3/4
27	5	6	5	6	5	3/5	5	3/7
28	4	4/-	4	2/-	3	3/-	3	2/-

## Appendix D: Modal Frequency Histograms for Survey Questions

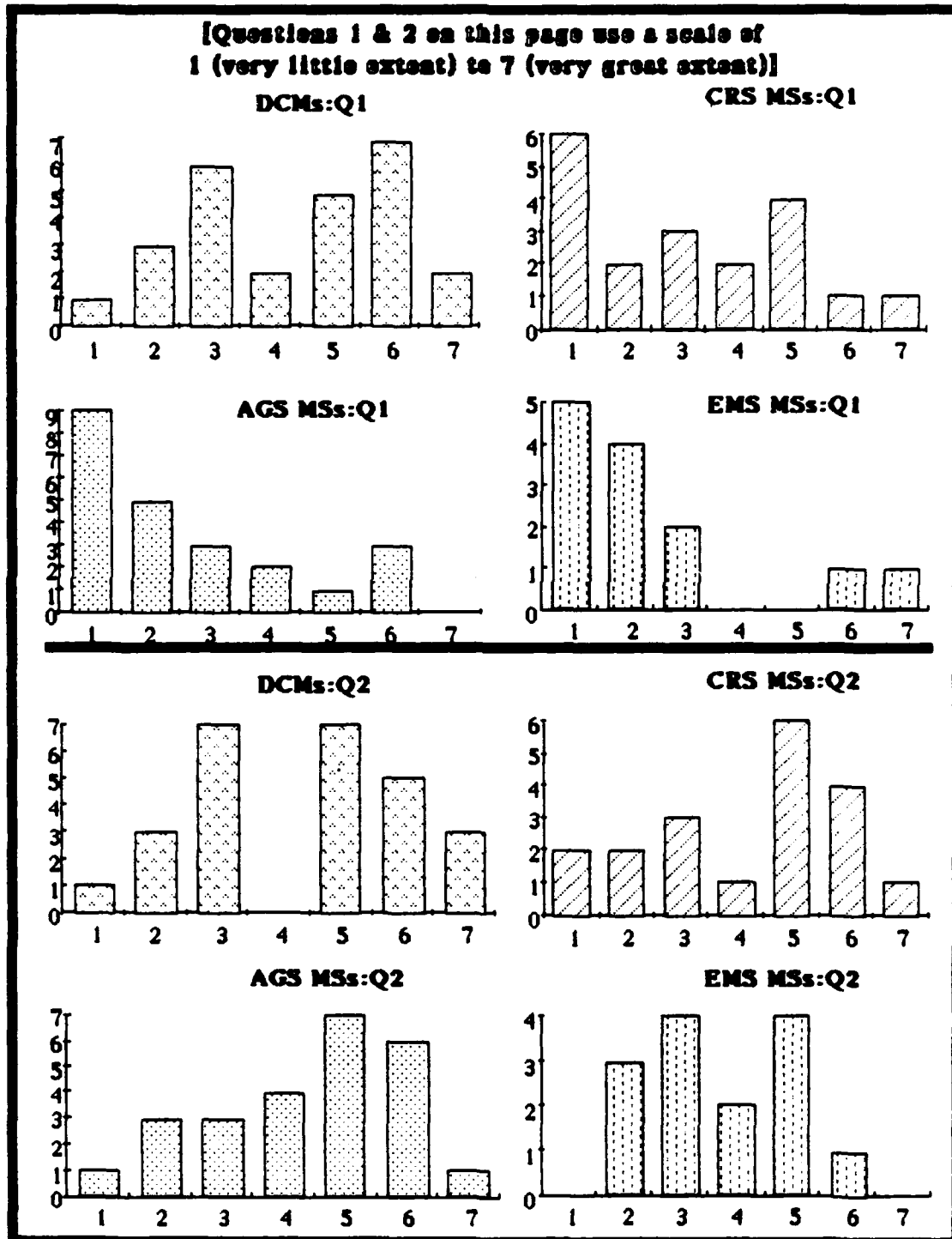


Figure D.1. Survey Response Histograms [Section 1]

[Questions 3 & 4 on this page use a scale of  
1 (very little extent) to 7 (very great extent)]

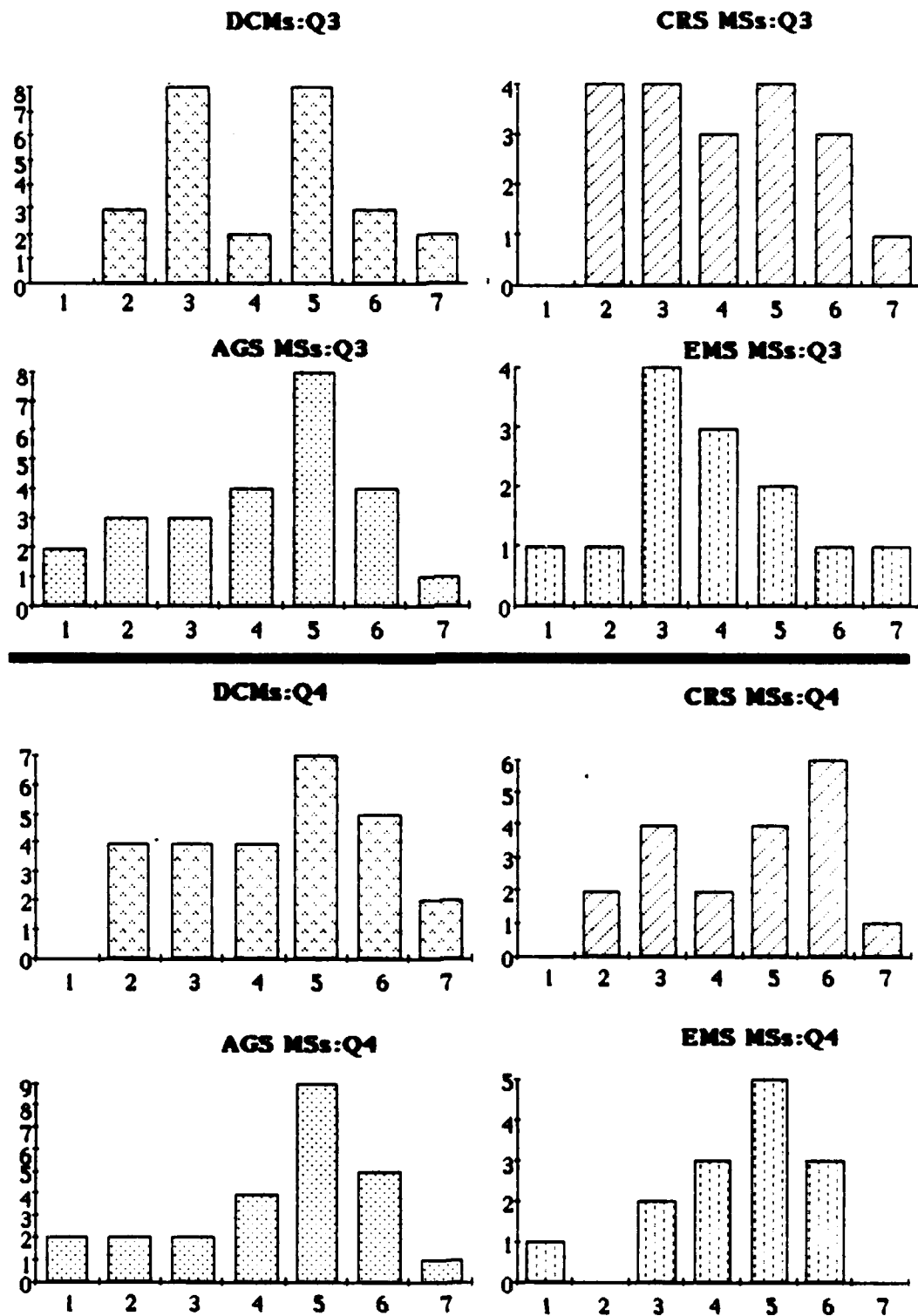


Figure D.2. Survey Response Histograms [Section 1]

[Questions 5 & 6 on this page use a scale of  
1 (very little extent) to 7 (very great extent)]

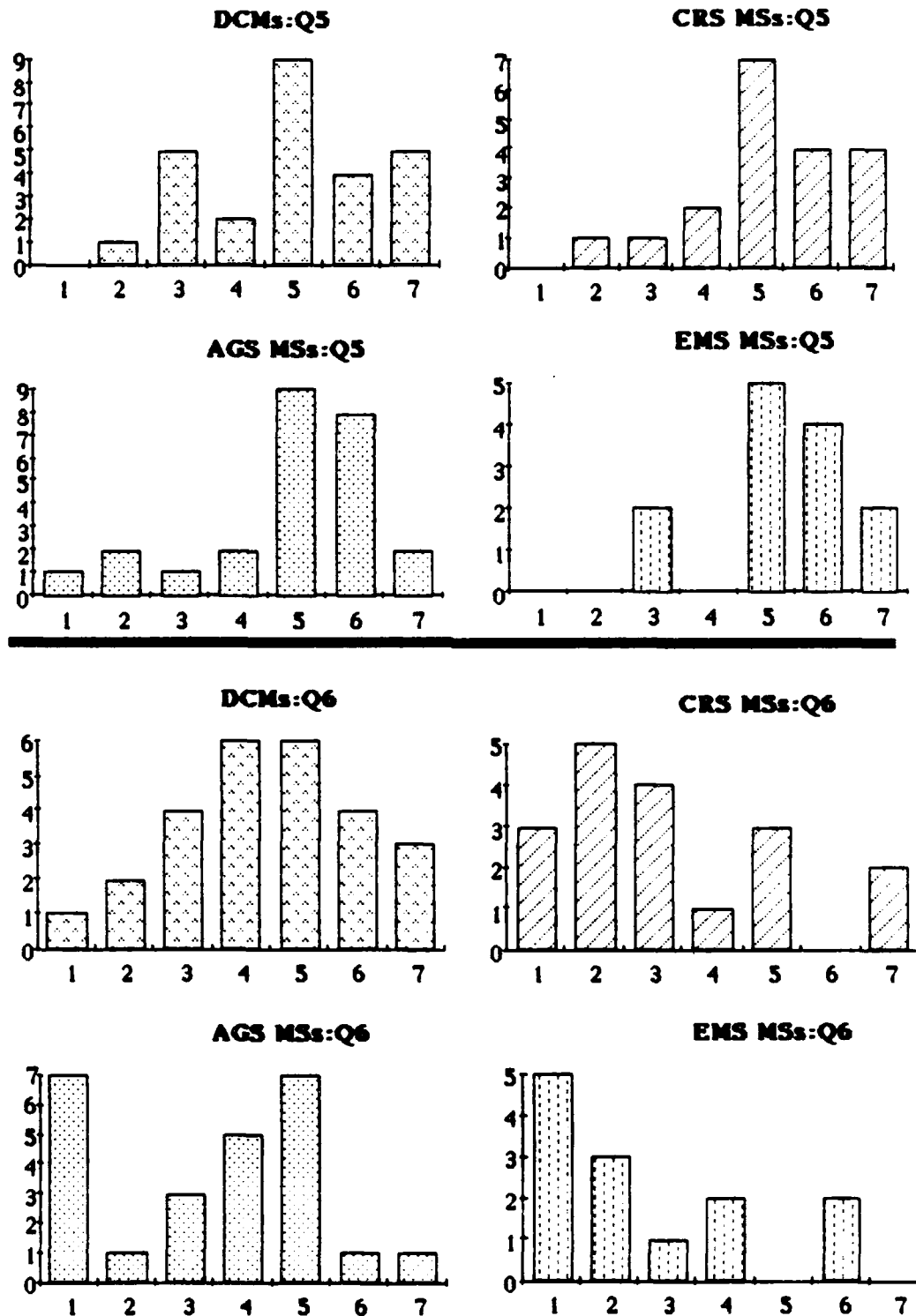


Figure D.3. Survey Response Histograms [Section 1]



[Questions 7 & 8 on this page use a scale of  
1 (very little extent) to 7 (very great extent)]

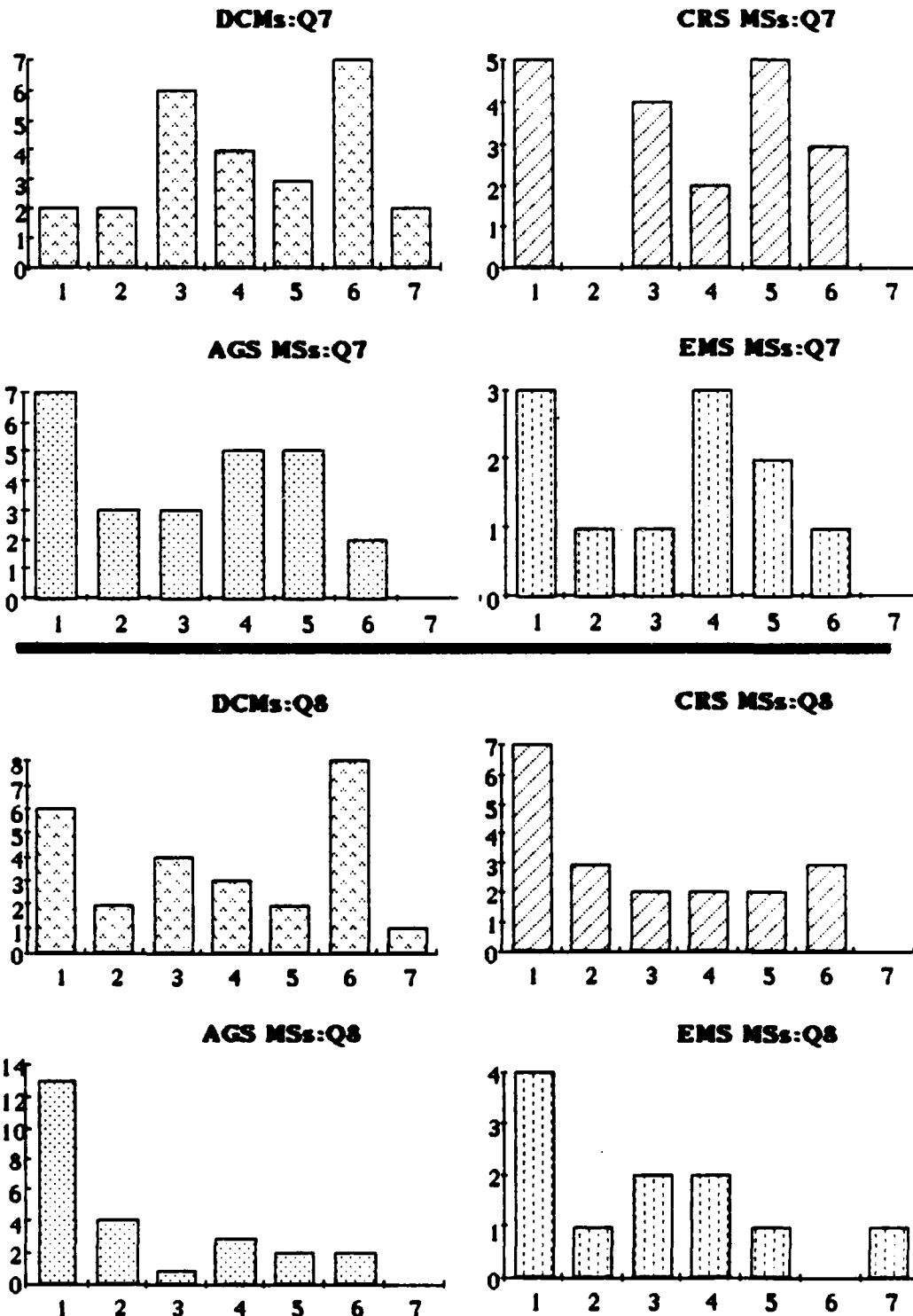


Figure D.4. Survey Response Histograms [Section 1]

[Questions 9 & 10 on this page use a scale of  
1 (very little extent) to 7 (very great extent)]

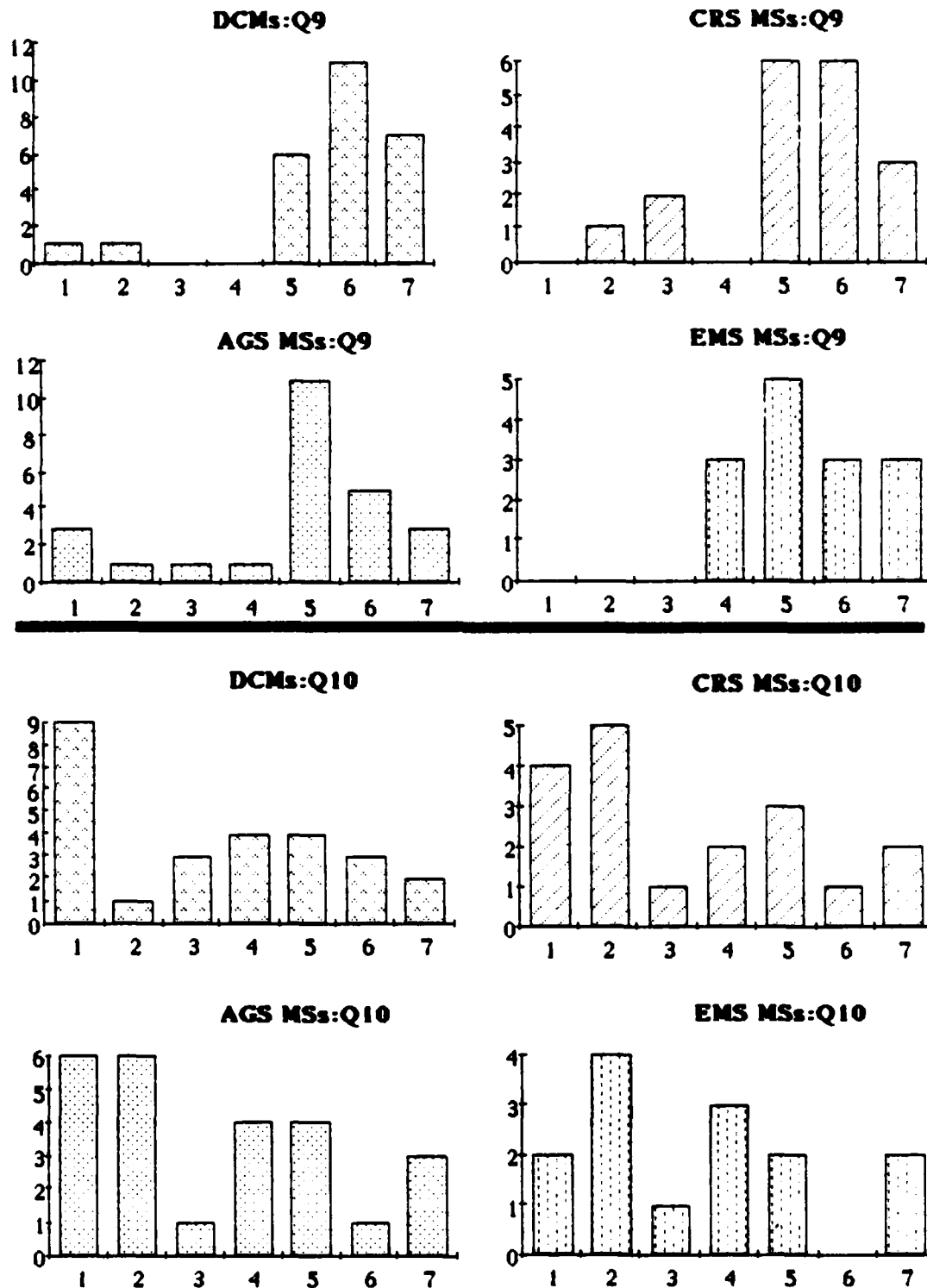
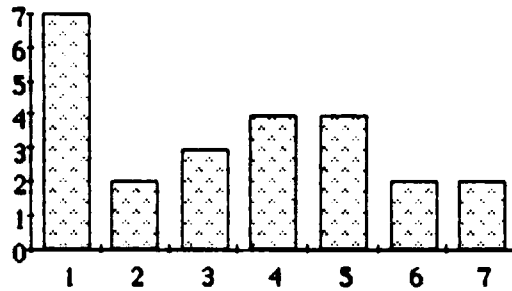


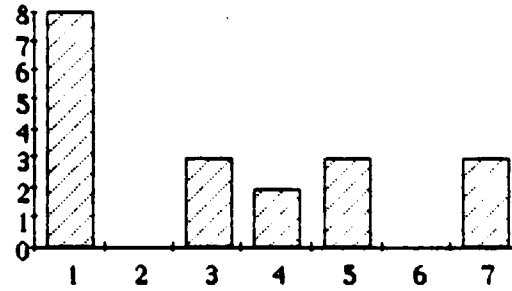
Figure D.5. Survey Response Histograms [Section 1]

[Questions 11 & 12 on this page use a scale of 1 (very little extent) to 7 (very great extent)]

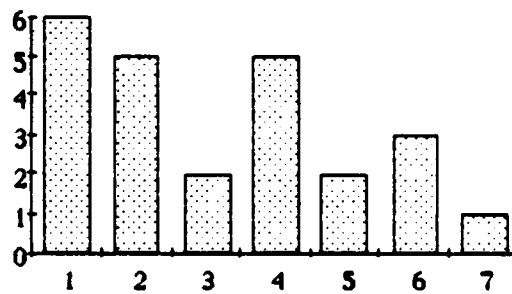
**DCMs:Q11**



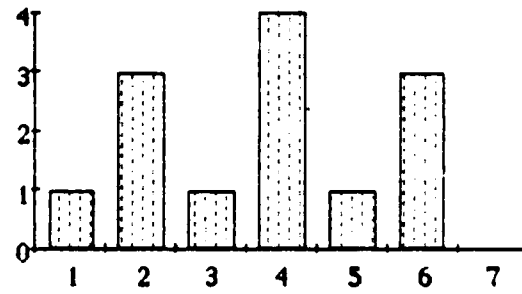
**CRS MSs:Q11**



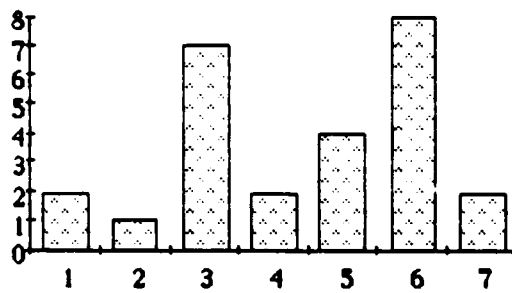
**AGS MSs:Q11**



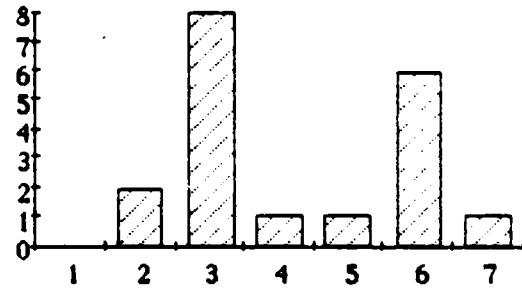
**EMS MSs:Q11**



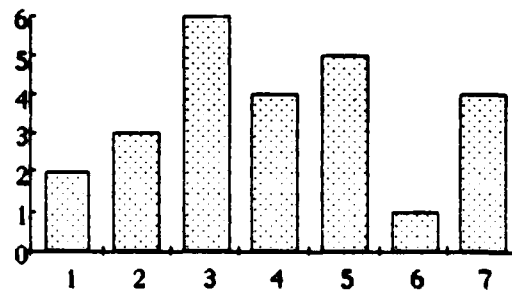
**DCMs:Q12**



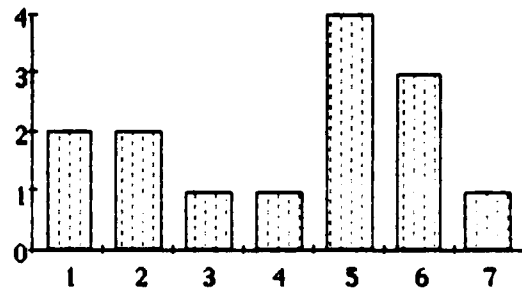
**CRS MSs:Q12**



**AGS MSs:Q12**



**EMS MSs:Q12**



**Figure D.6. Survey Response Histograms [Section 1]**

[Questions 13 & 14 on this page use a scale of 1 (very little extent) to 7 (very great extent)]

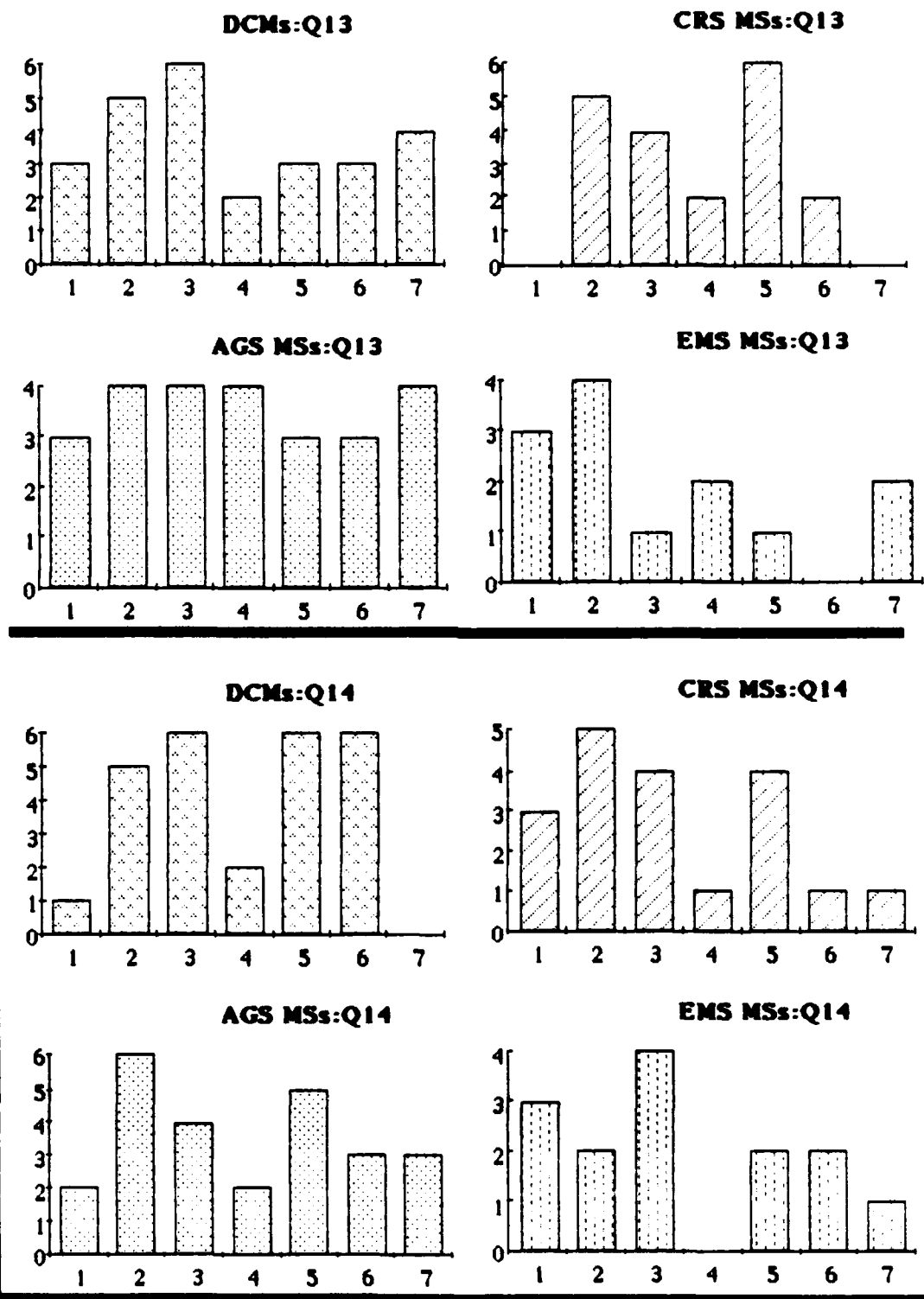


Figure D.7. Survey Response Histograms [Section 1]

[Questions 15 & 16 on this page use a scale of  
1 (very little extent) to 7 (very great extent)]

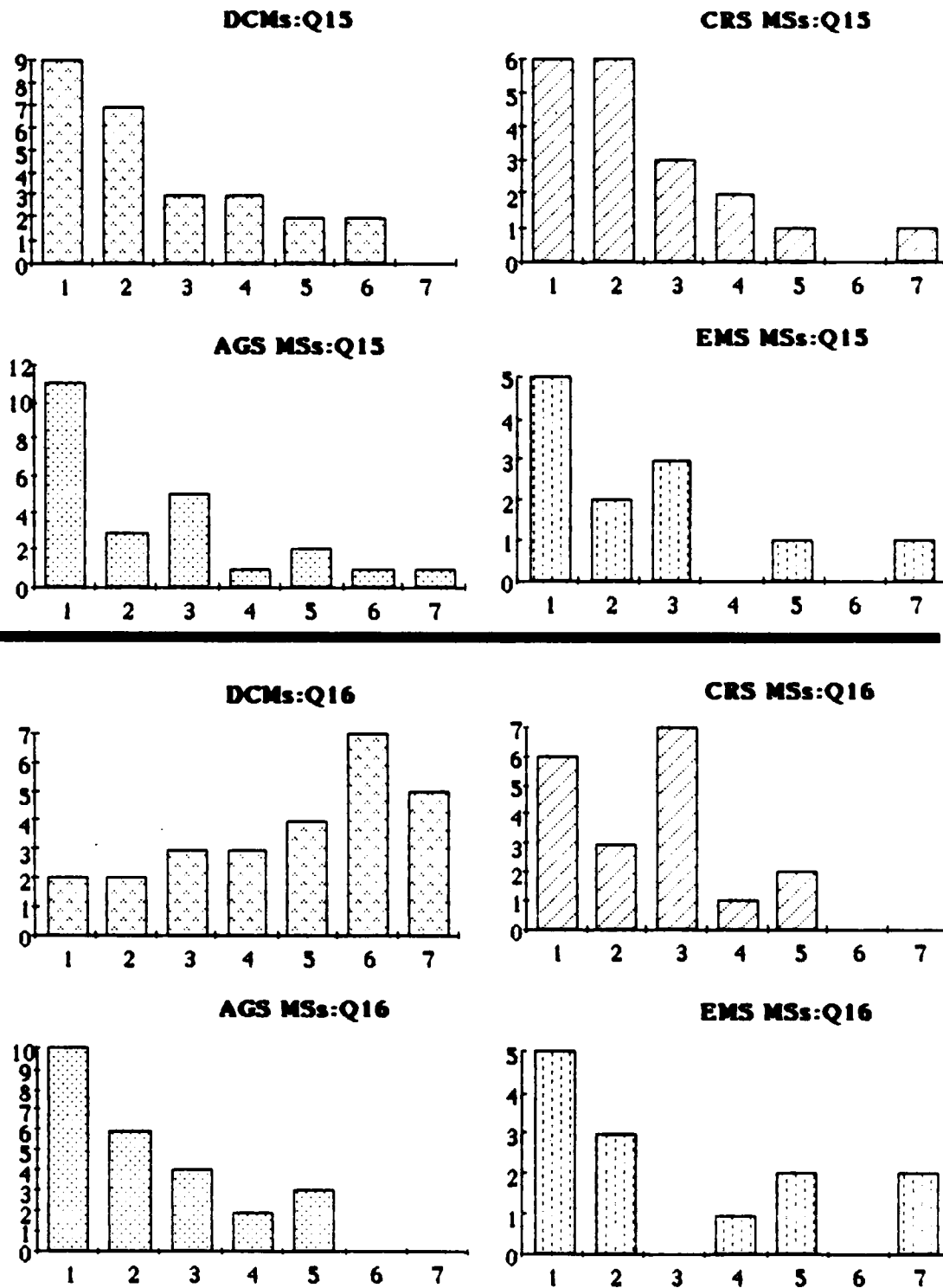
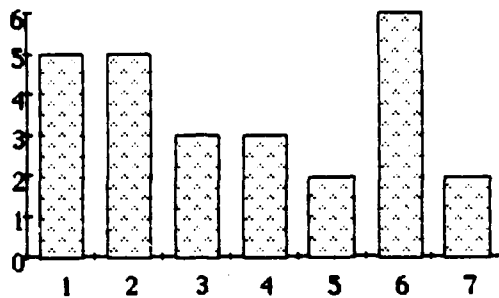


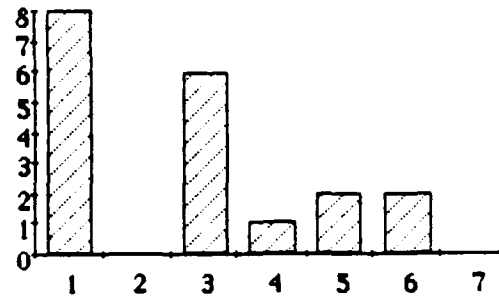
Figure D.8. Survey Response Histograms [Section 1]

[Questions 17 & 18 on this page use a scale of  
1 (very little extent) to 7 (very great extent)]

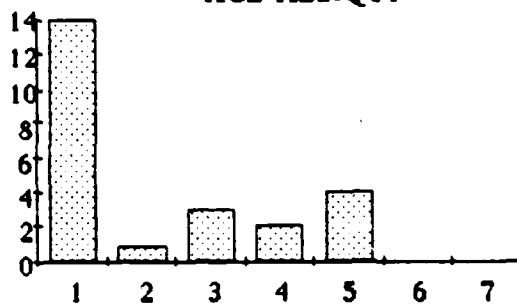
DCMs:Q17



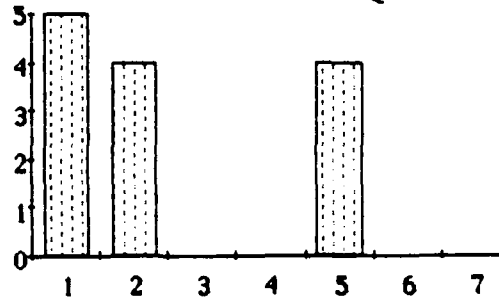
CRS MSs:Q17



AGS MSs:Q17



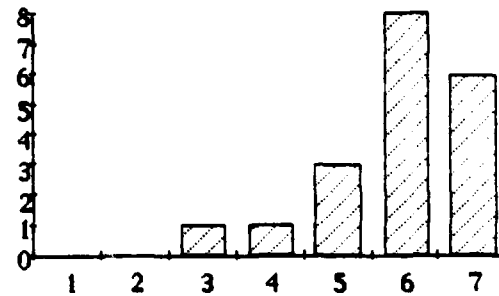
EMS MSs:Q17



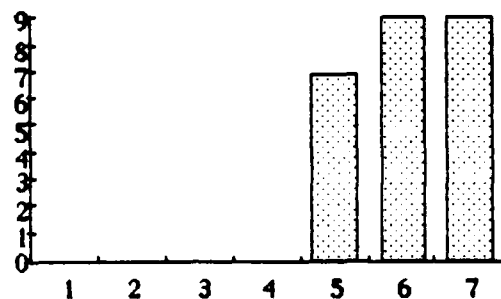
DCMs:Q18



CRS MSs:Q18



AGS MSs:Q18



EMS MSs:Q18

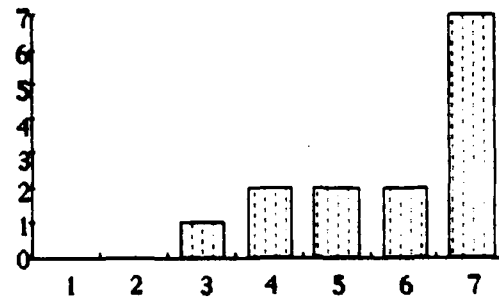
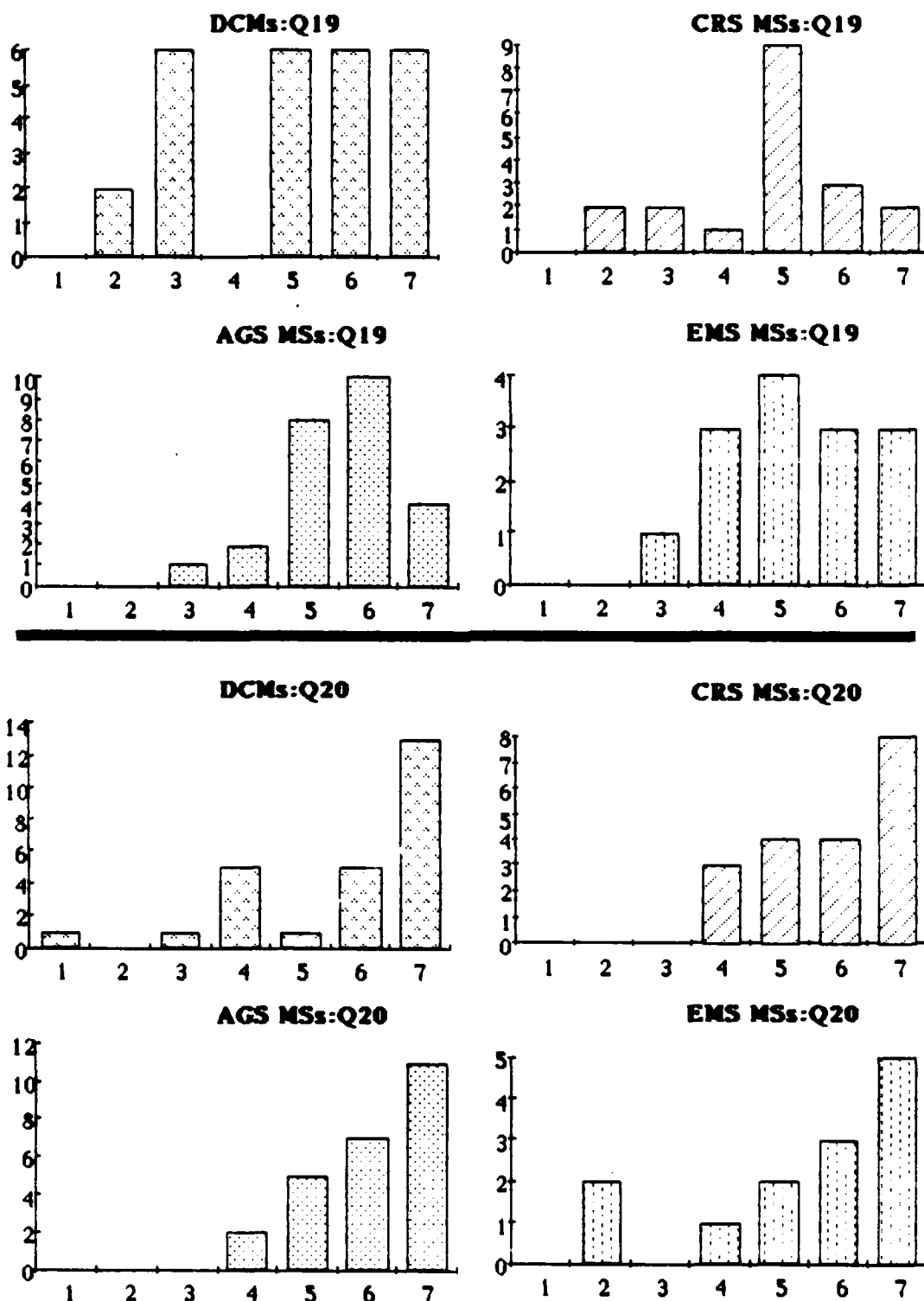


Figure D.9. Survey Response Histograms [Section 1]

**[Question 19 on this page uses a scale of 1 (very little extent) to 7 (very great extent) & Question 20 uses a scale of 1 (strongly disagree) to 7 (strongly agree)]**



**Figure D.10. Survey Response Histograms [Section 1]**

[Questions 21 & 22 on this page use a scale of  
1 (strongly disagree) to 7 (strongly agree)]

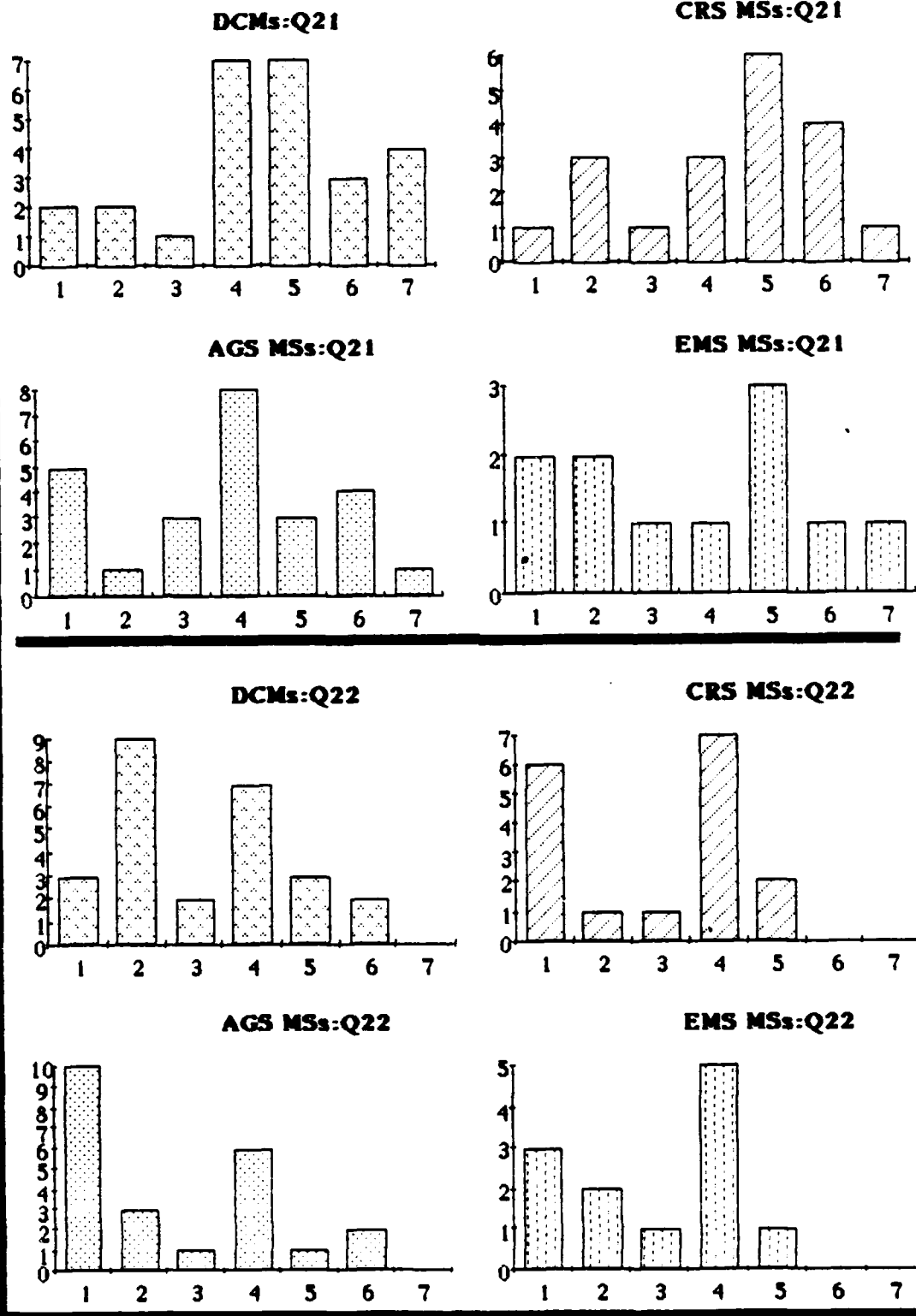


Figure D.11. Survey Response Histograms [Section 1]



[Questions 23 & 24 on this page use a scale of  
1 (strongly disagree) to 7 (strongly agree)]

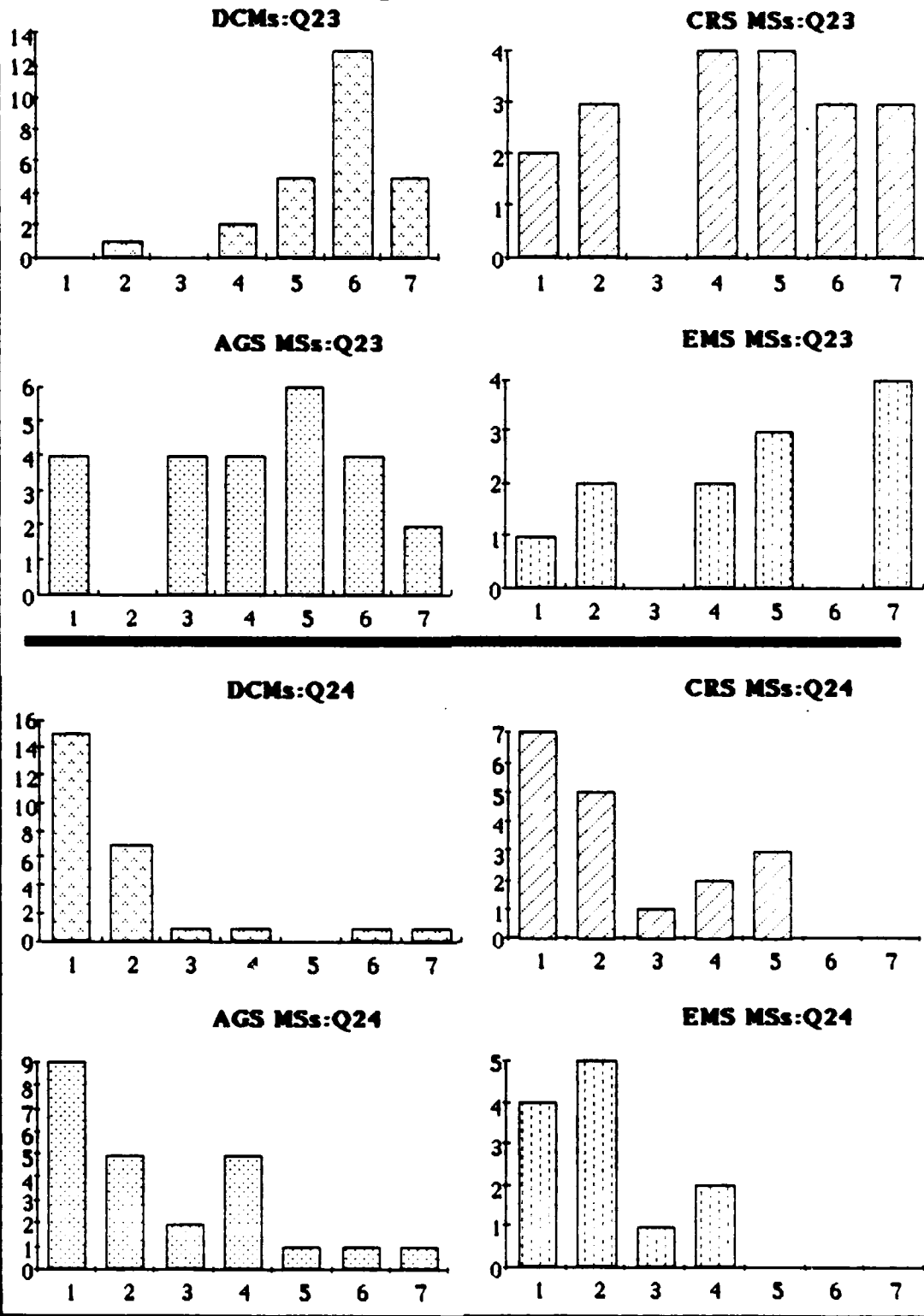


Figure D.12. Survey Response Histograms [Section 1]

[Questions 25 & 26 on this page use a scale of 1 (strongly disagree) to 7 (strongly agree)]

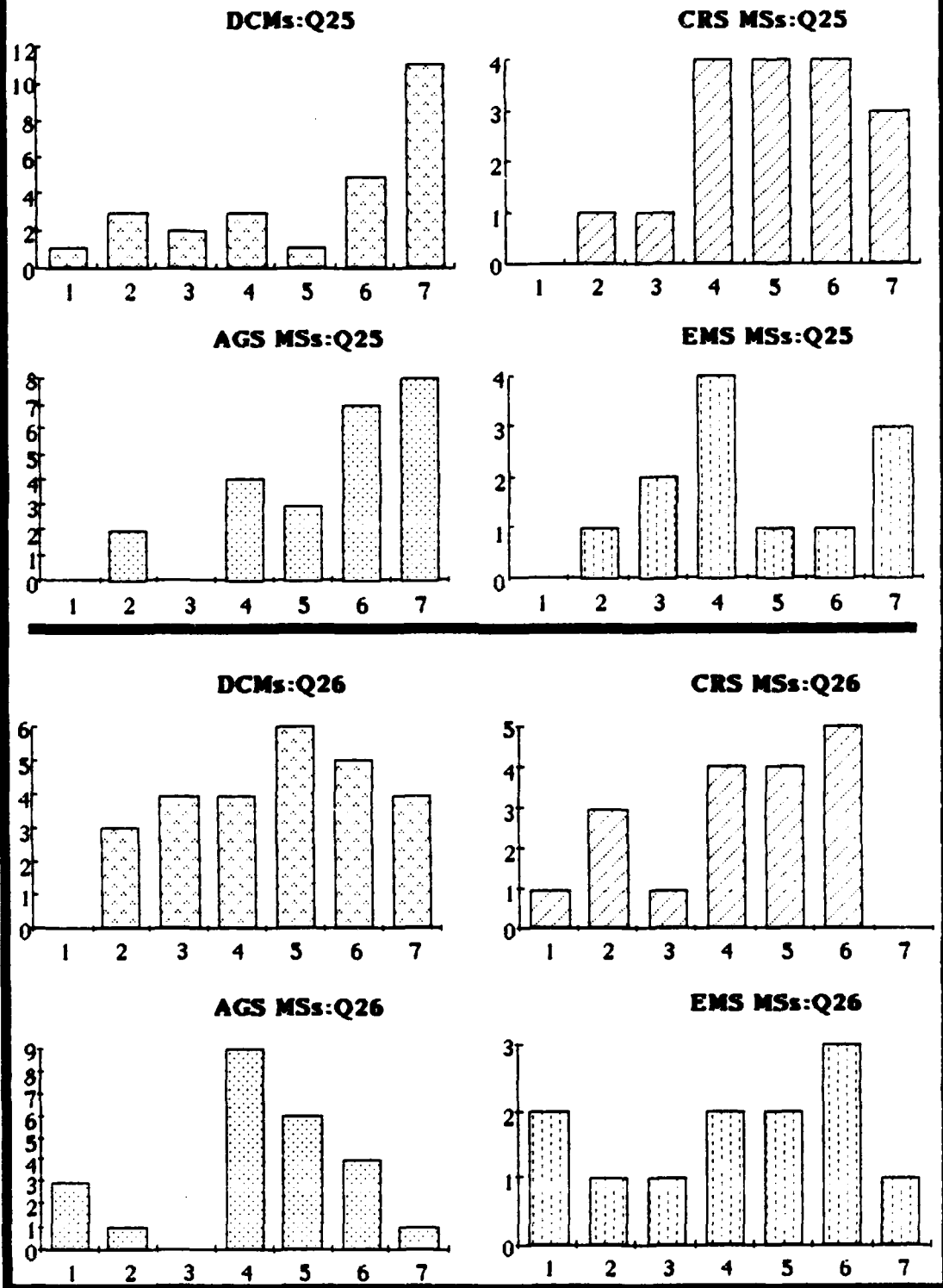


Figure D.13. Survey Response Histograms [Section 1]

[Questions 27 & 28 on this page use scales of  
1 (strongly disagree) to 7 (strongly agree)]

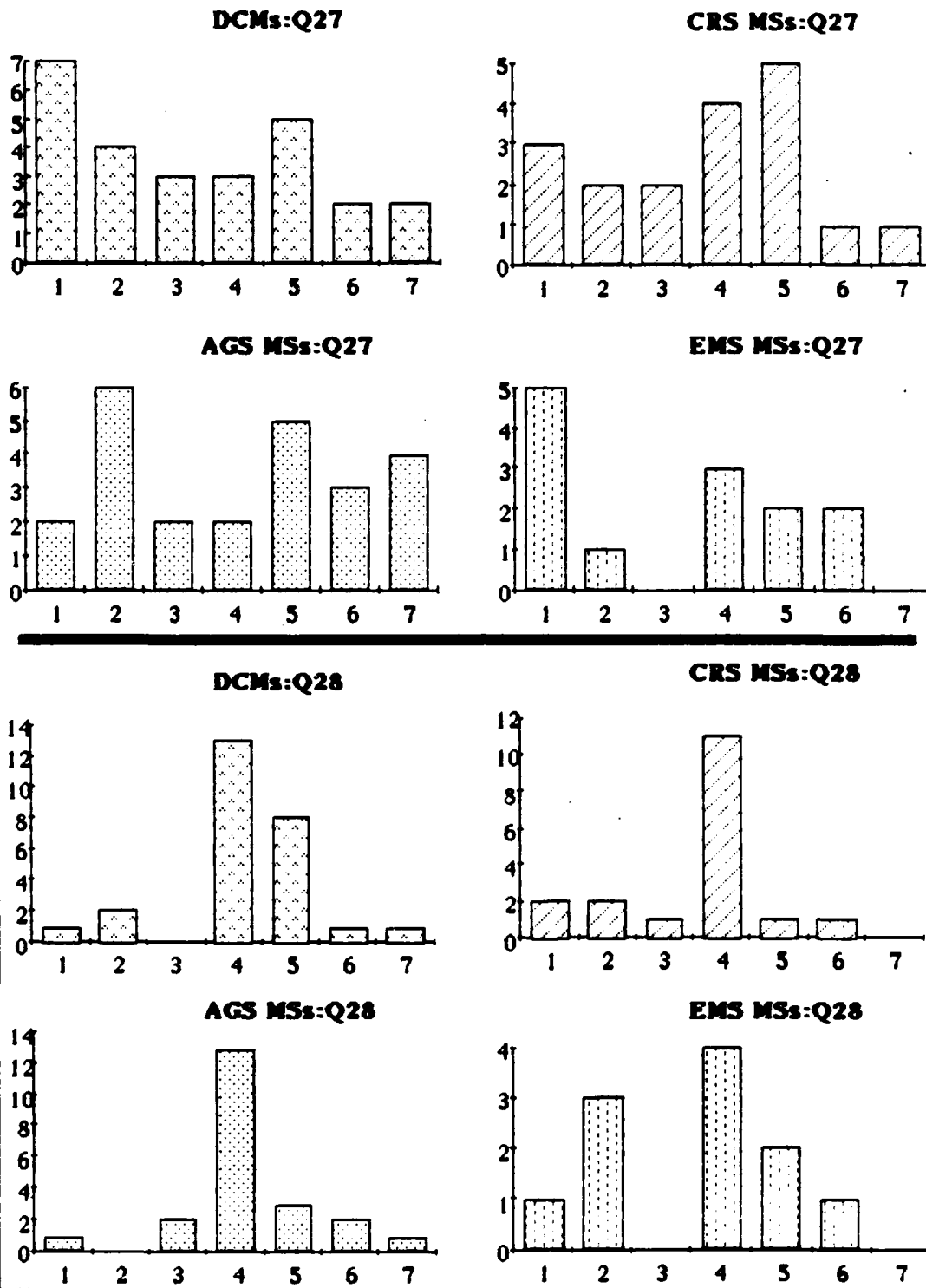


Figure D.14. Survey Response Histograms [Section 1]

[Questions 1 & 2 on this page use a scale of 1 (strongly disagree) to 7 (strongly agree)]

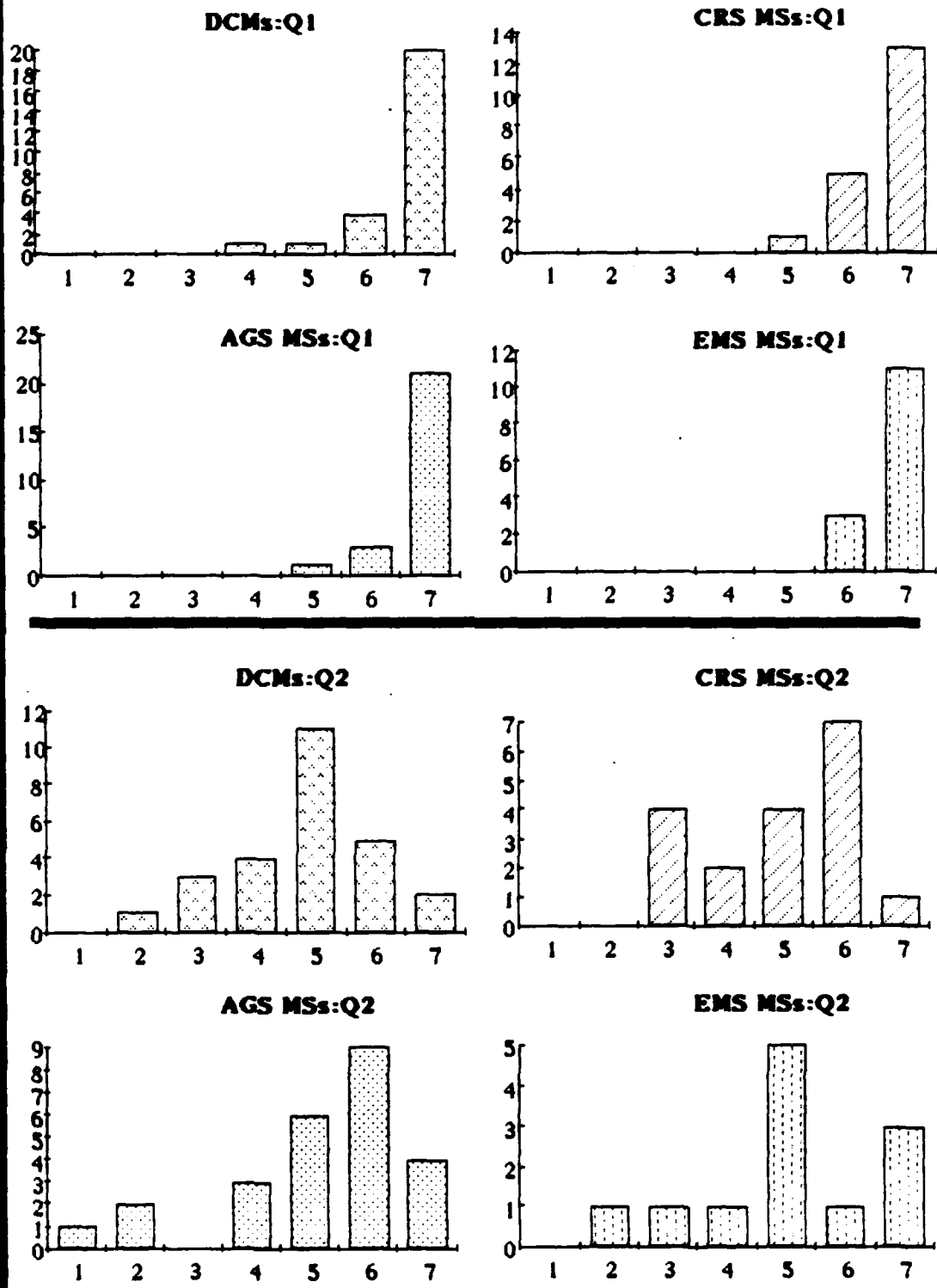


Figure D.15. Survey Response Histograms [Section 2]

[Questions 3 & 4 on this page use a scale of 1 (strongly disagree) to 7 (strongly agree)]

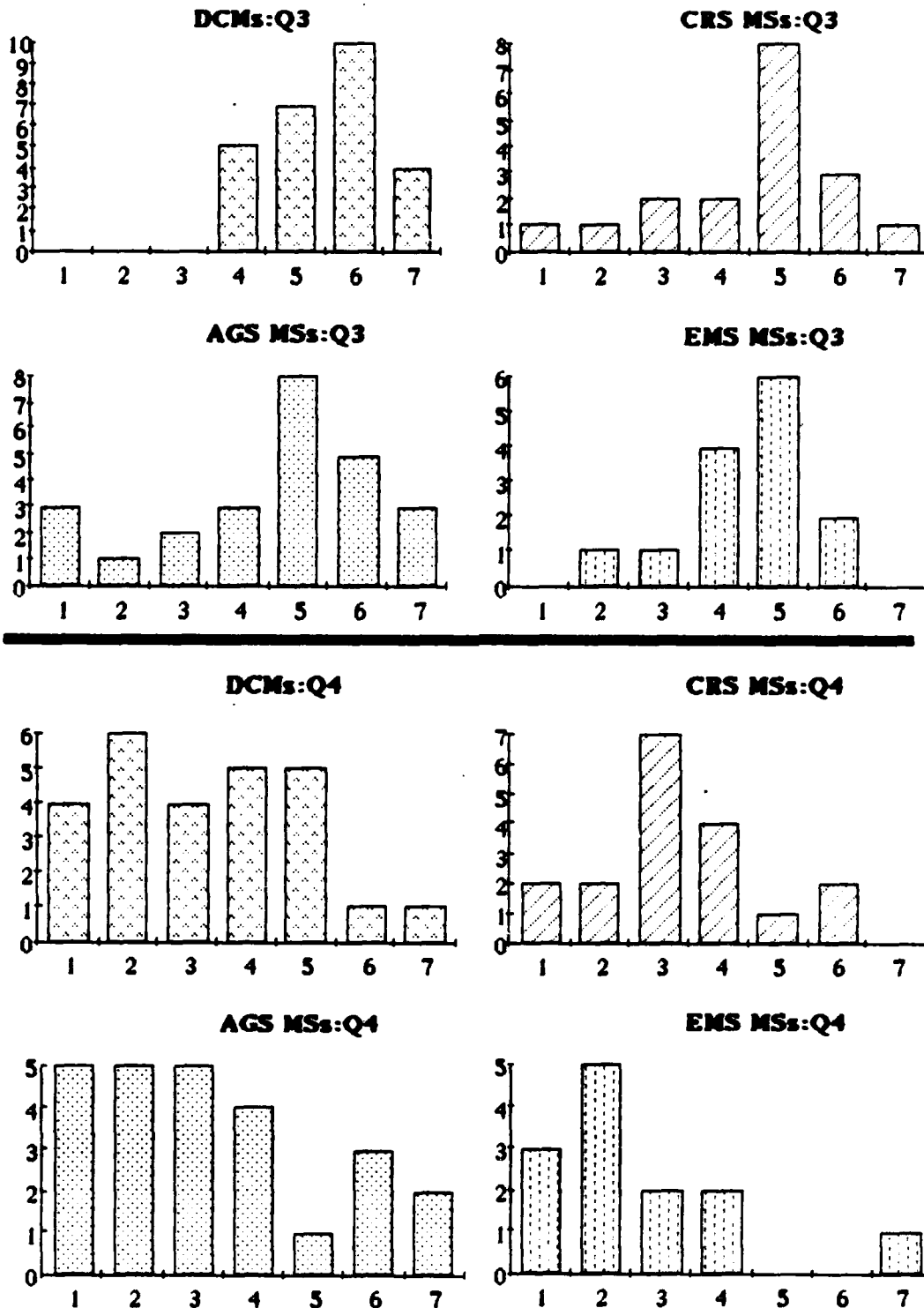


Figure D.16. Survey Response Histograms [Section 2]

[Questions 5 & 6 on this page use a scale of  
1 (strongly disagree) to 7 (strongly agree)]

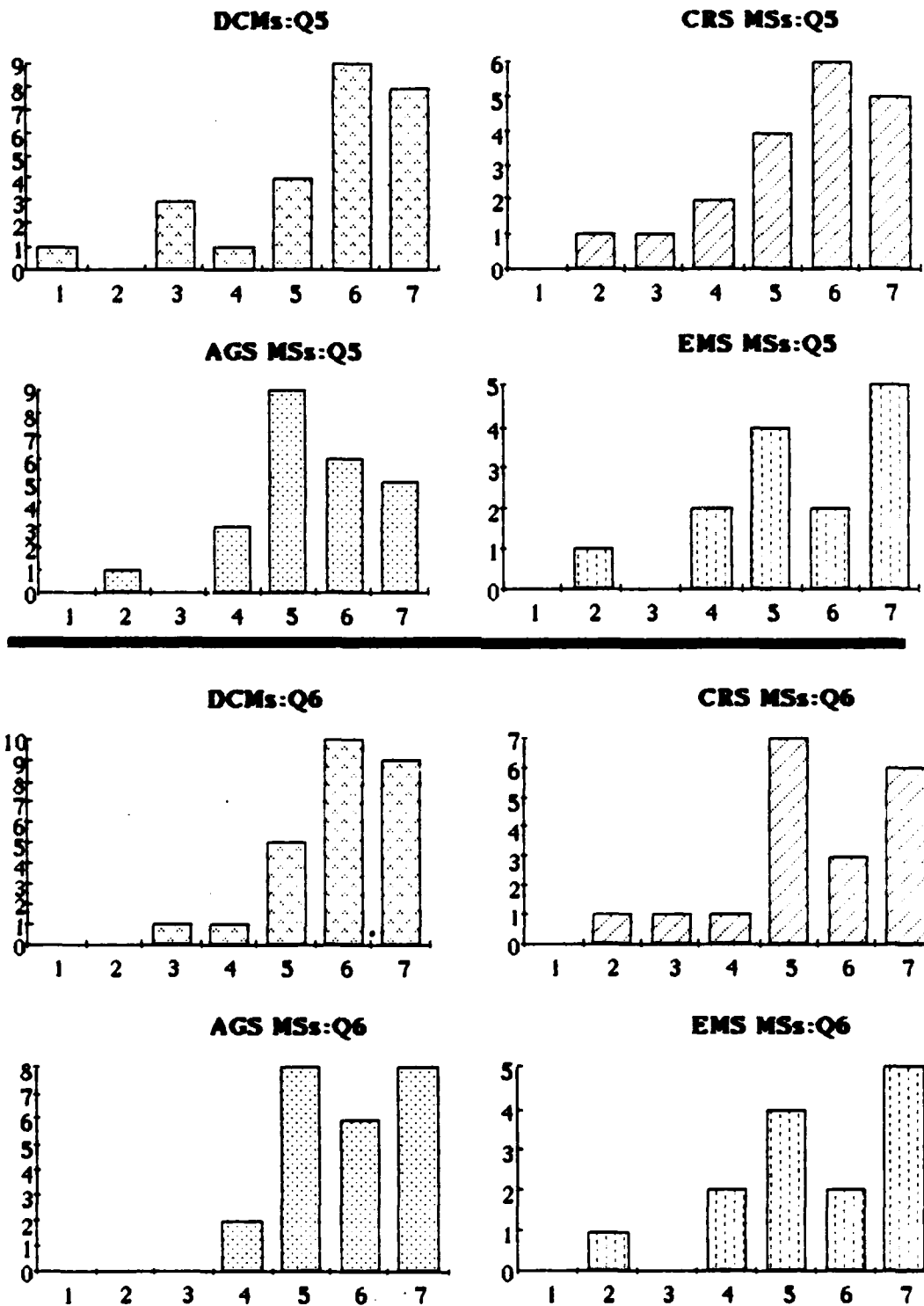
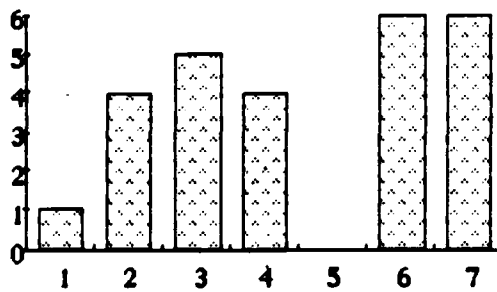


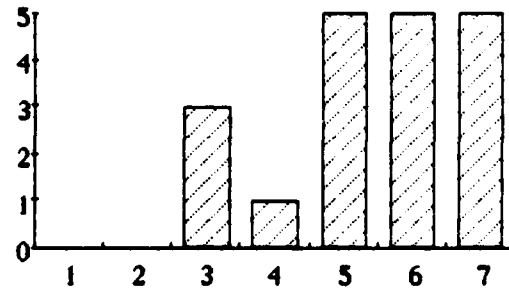
Figure D.17. Survey Response Histograms [Section 2]

[Questions 7 & 8 on this page use a scale of  
1 (strongly disagree) to 7 (strongly agree)]

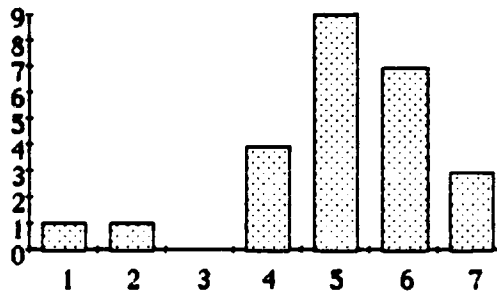
**DCMs:Q7**



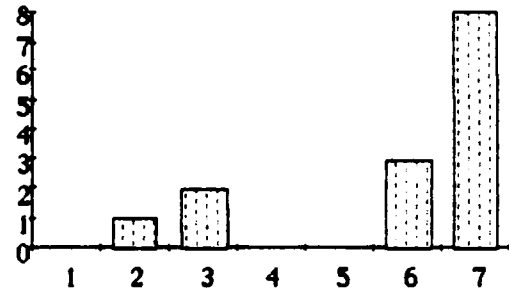
**CRS MSs:Q7**



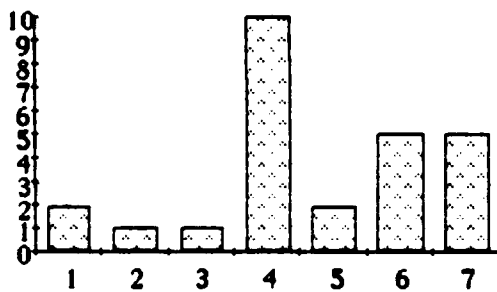
**AGS MSs:Q7**



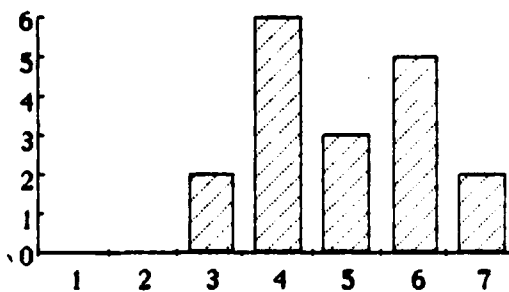
**EMS MSs:Q7**



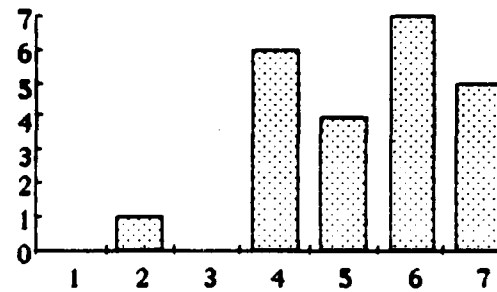
**DCMs:Q8**



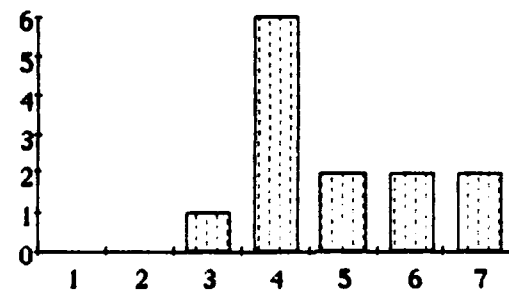
**CRS MSs:Q8**



**AGS MSs:Q8**



**EMS MSs:Q8**



**Figure D.18. Survey Response Histograms [Section 2]**

[Questions 9 & 10 on this page use a scale of 1 (strongly disagree) to 7 (strongly agree)]

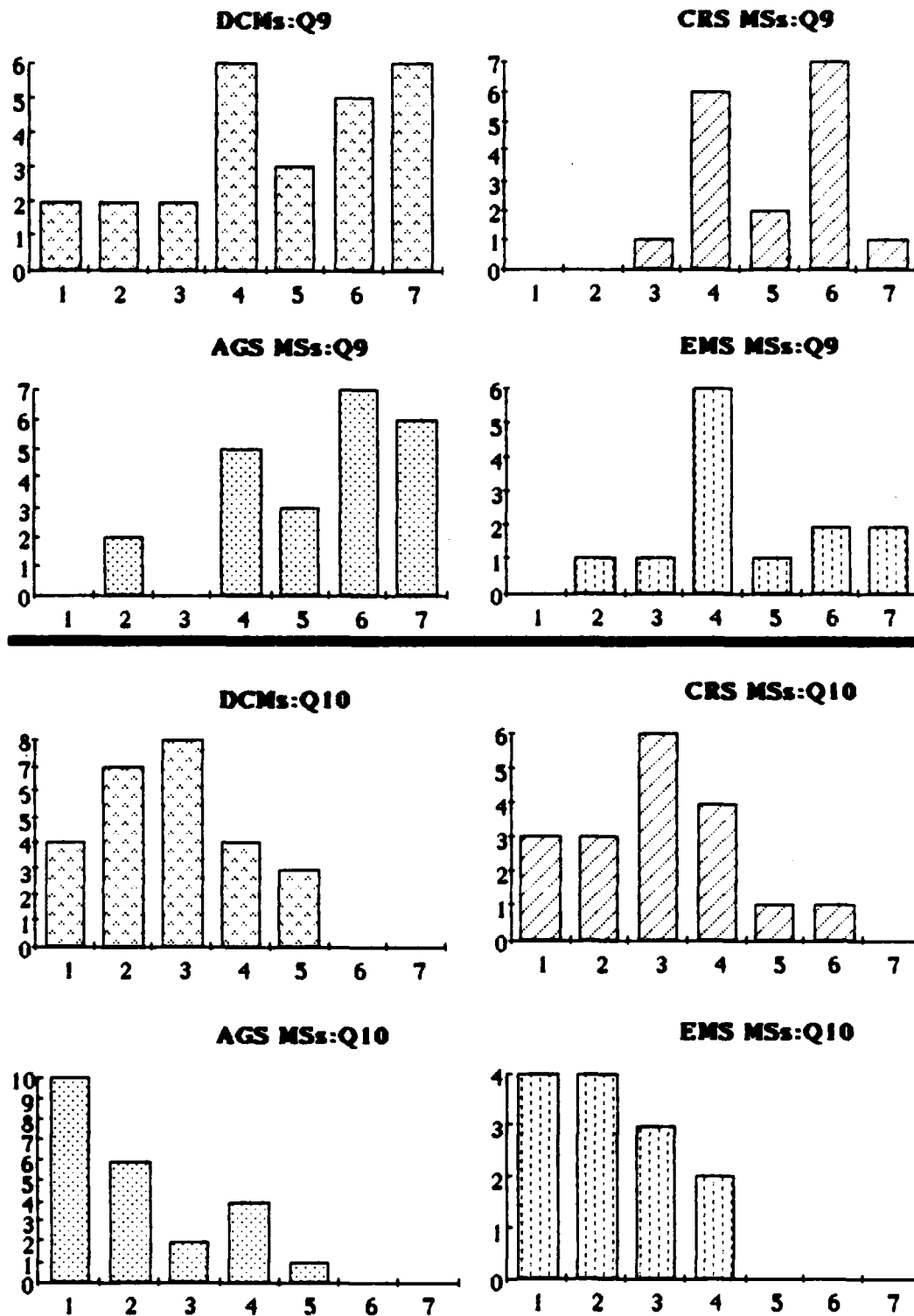


Figure D.19. Survey Response Histograms [Section 2]



[Questions 11 & 12 on this page use a scale of  
1 (strongly disagree) to 7 (strongly agree)]

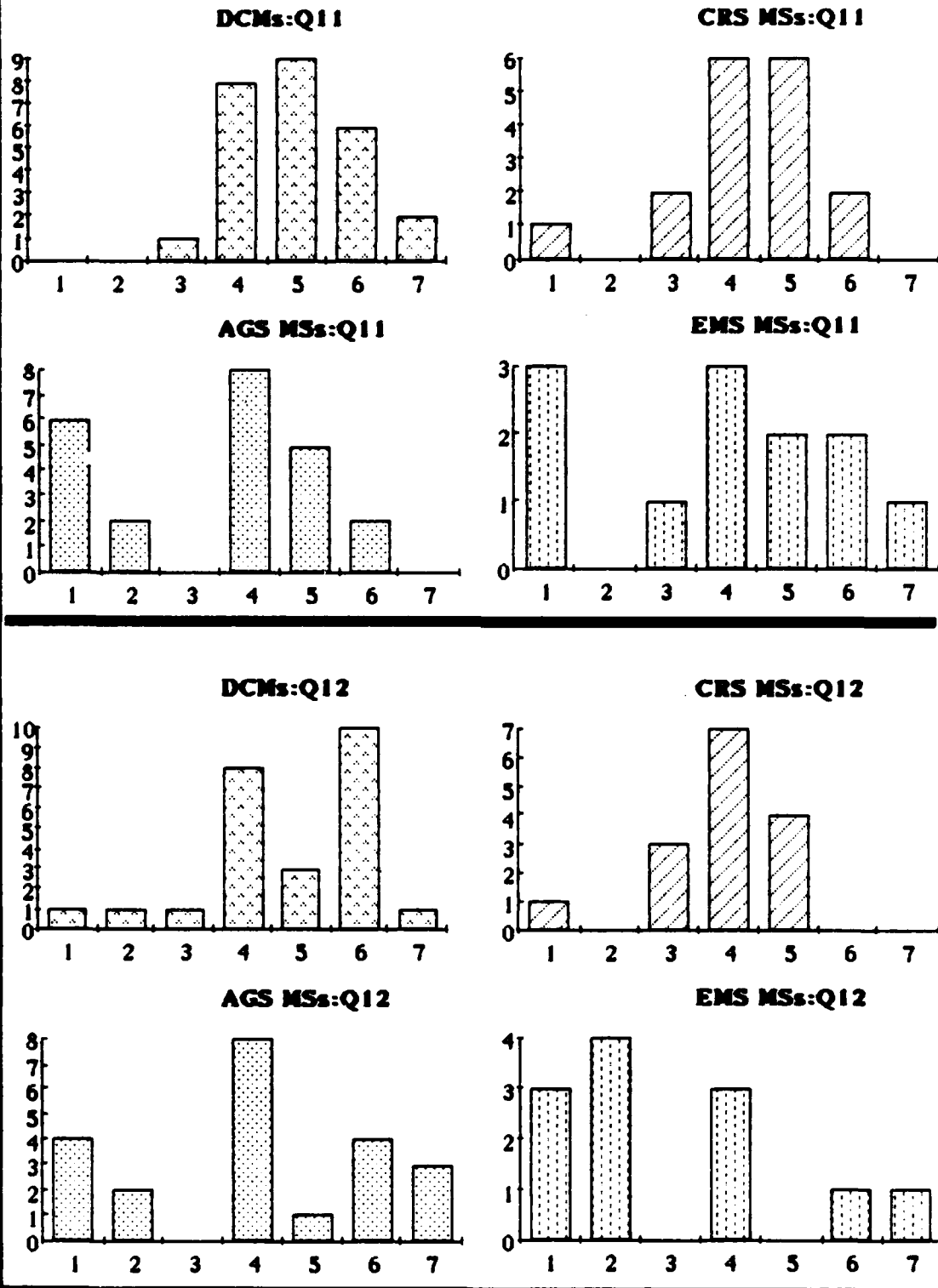


Figure D.20. Survey Response Histograms [Section 2]

[Questions 13 & 14 on this page use a scale of  
1 (strongly disagree) to 7 (strongly agree)]

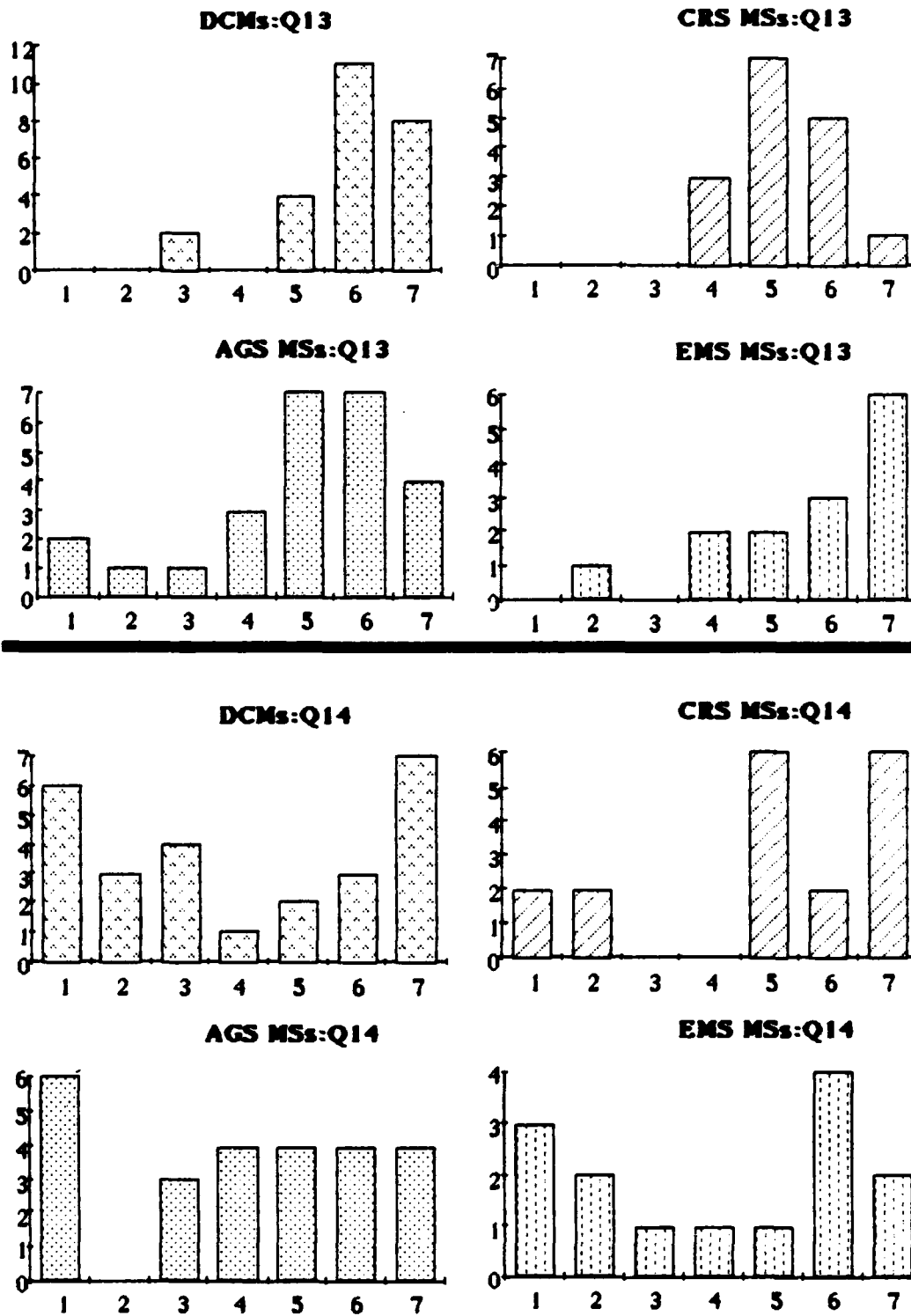


Figure D.21. Survey Response Histograms [Section 2]

[Questions 15 & 16 on this page use a scale of 1 (strongly disagree) to 7 (strongly agree)]

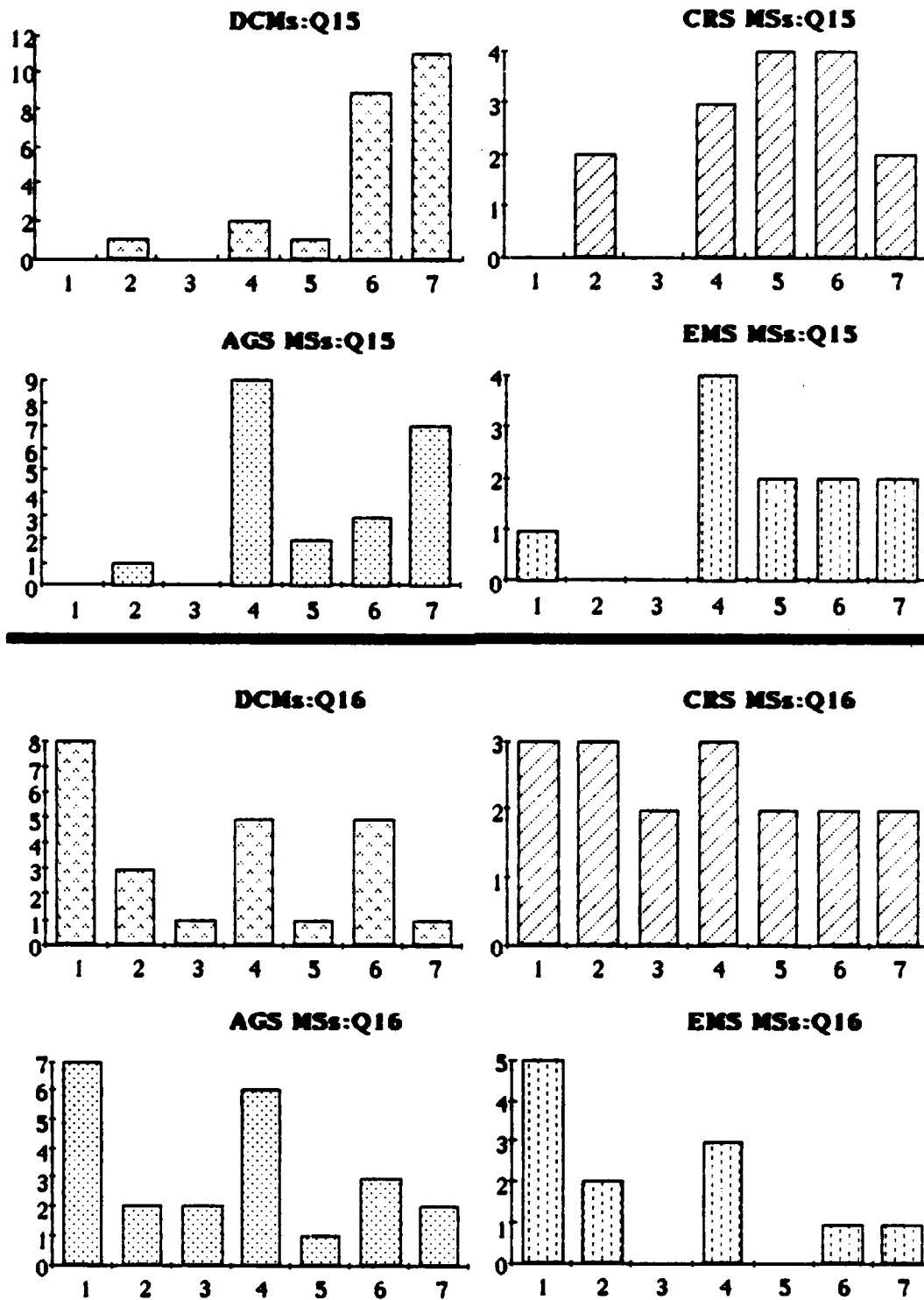


Figure D.22. Survey Response Histograms [Section 2]

[Questions 17 & 18 on this page use a scale of 1 (very little extent) to 7 (very great extent)]

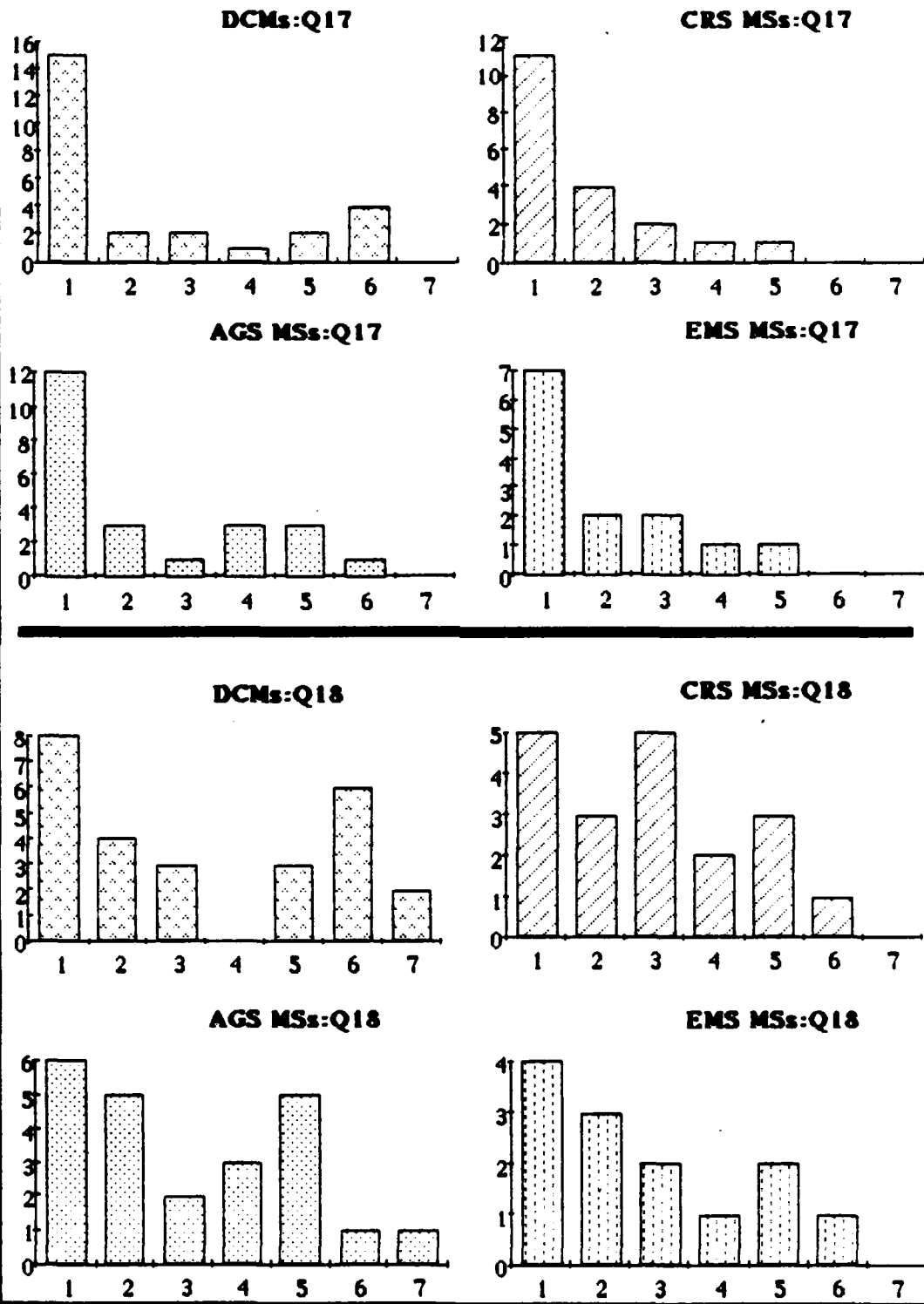


Figure D.23. Survey Response Histograms [Section 2]

[Questions 19 & 20 on this page use a scale of 1 (very little extent) to 7 (very great extent)]

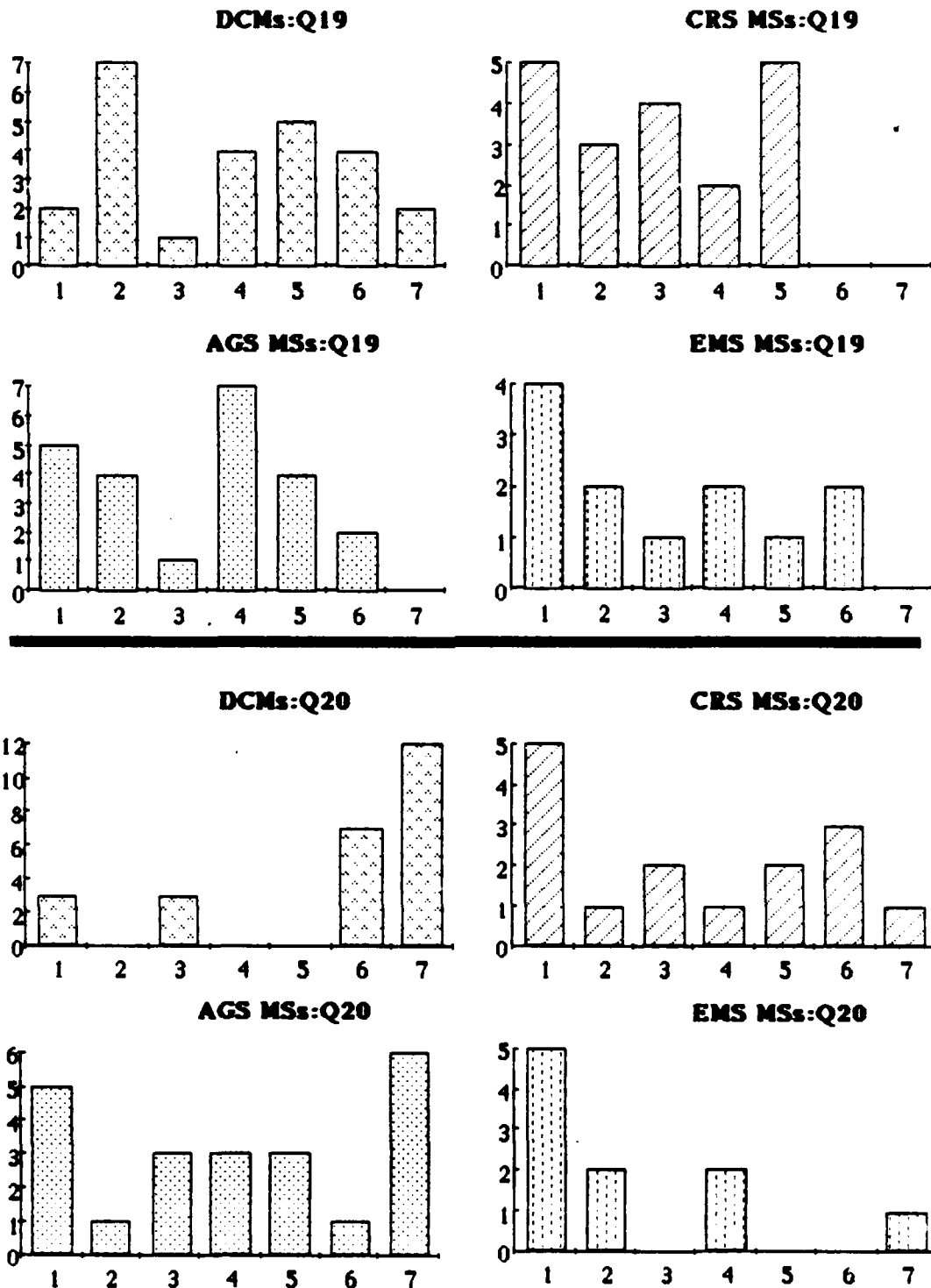
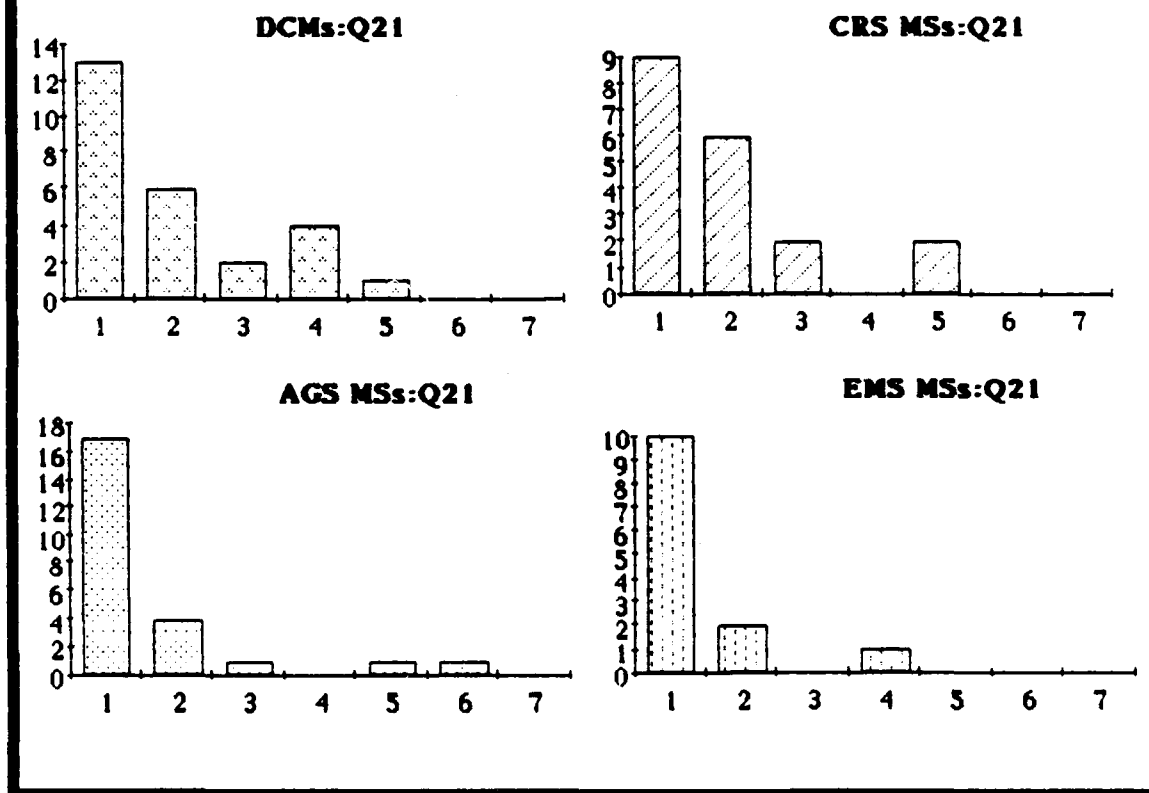


Figure D.24. Survey Response Histograms [Section 2]

**[Question 21 on this page uses a scale of  
1 (very little extent) to 7 (very great extent)]**



**Figure D.25. Survey Response Histograms [Section 2]**

[Questions 1 & 2 on this page use a scale of  
1 (very little extent) to 7 (very great extent)]

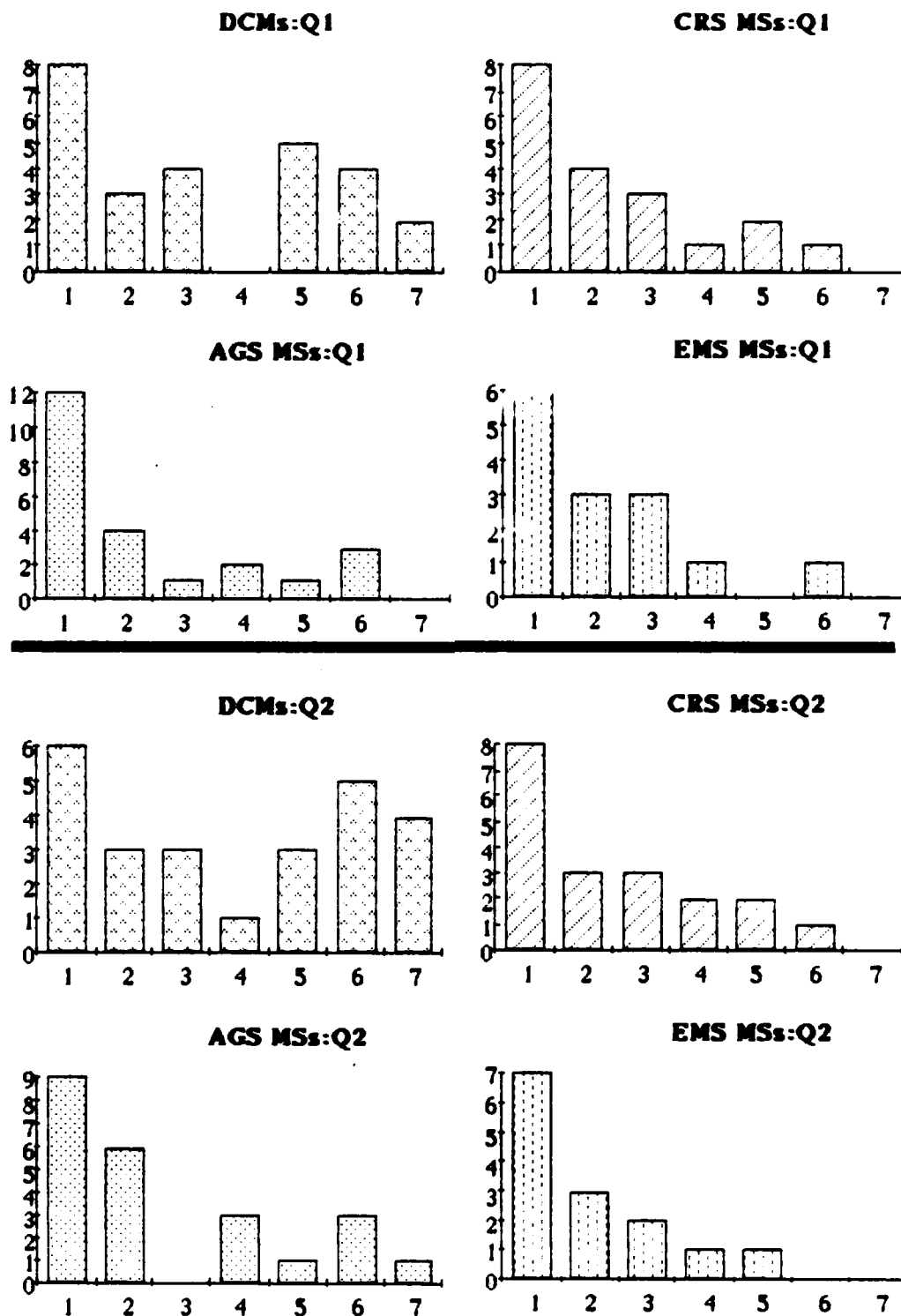


Figure D.26. Survey Response Histograms [Section 3]

[Questions 3 & 4 on this page use a scale of  
1 (very little extent) to 7 (very great extent)]

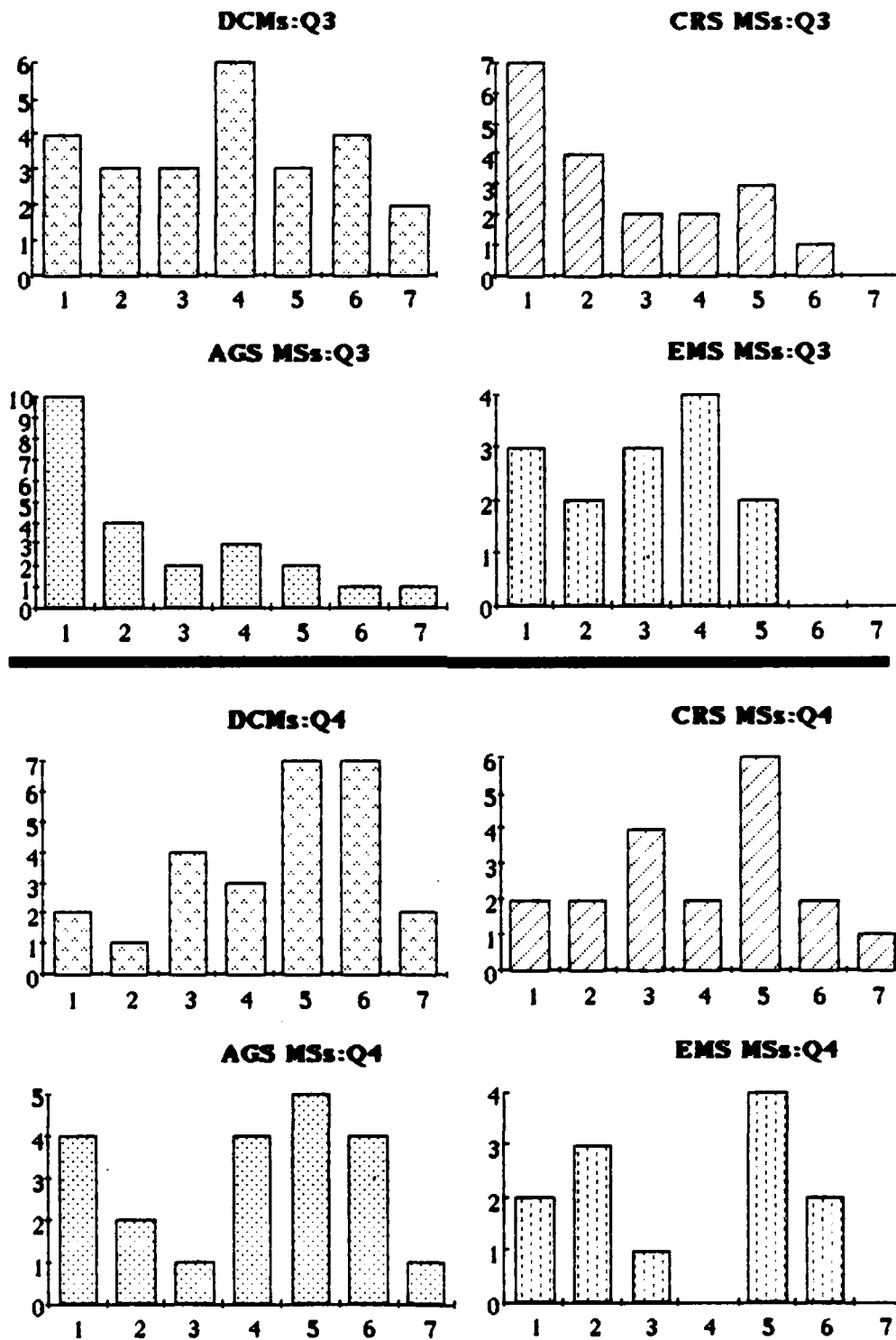
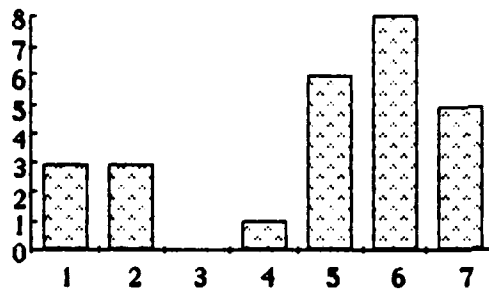


Figure D.27. Survey Response Histograms [Section 3]

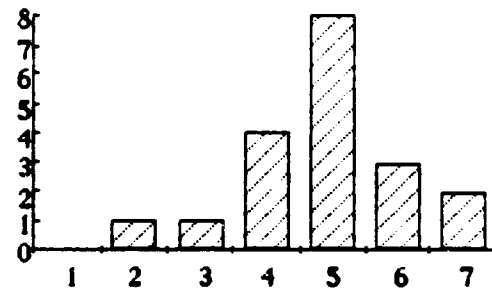


[Questions 5 & 6 on this page use a scale of  
1 (very little extent) to 7 (very great extent)]

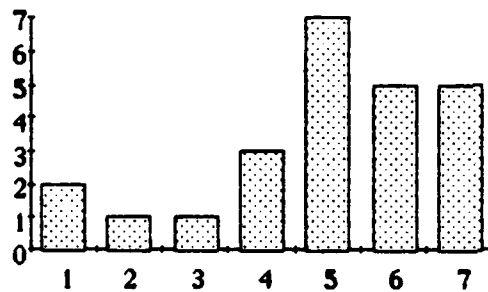
**DCMs:Q5**



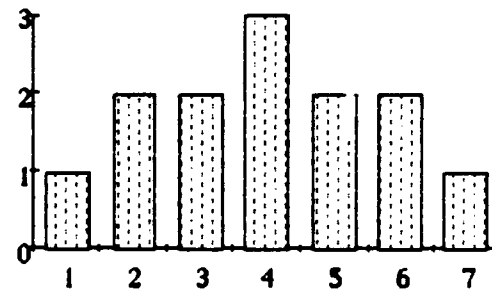
**CRS MSs:Q5**



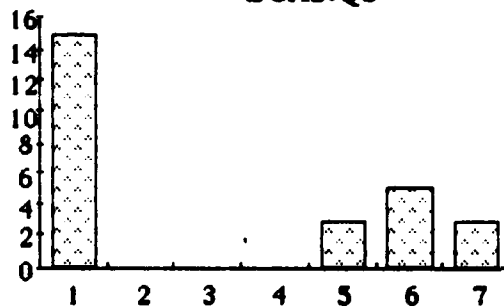
**AGS MSs:Q5**



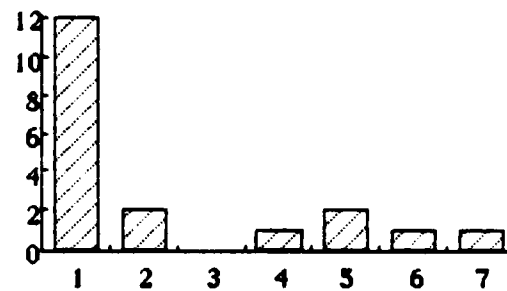
**EMS MSs:Q5**



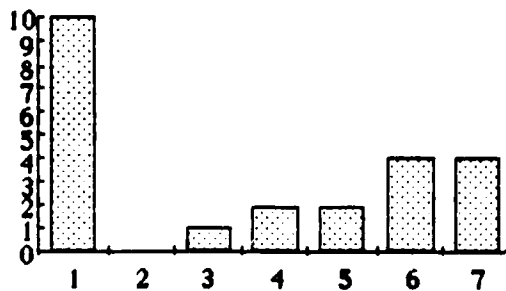
**DCMs:Q6**



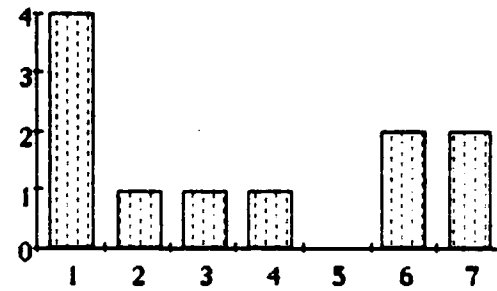
**CRS MSs:Q6**



**AGS MSs:Q6**



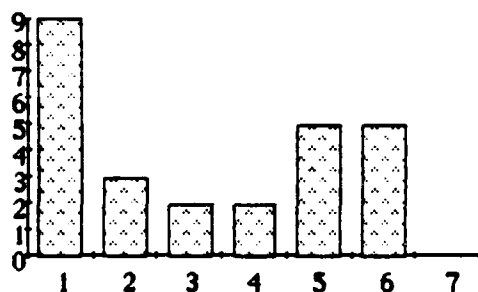
**EMS MSs:Q6**



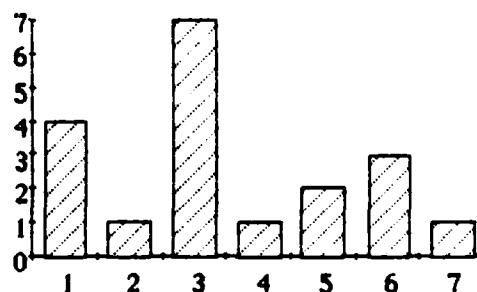
**Figure D.28. Survey Response Histograms [Section 3]**

[Questions 7 & 8 on this page use a scale of  
1 (very little extent) to 7 (very great extent)]

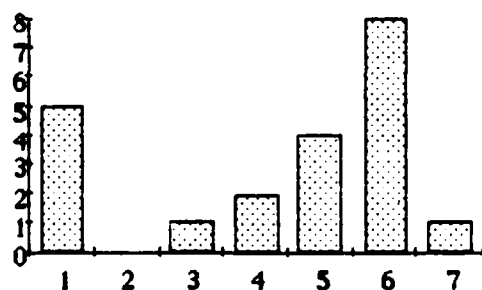
**DCMs:Q7**



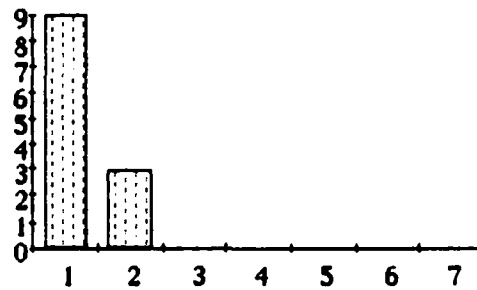
**CRS MSs:Q7**



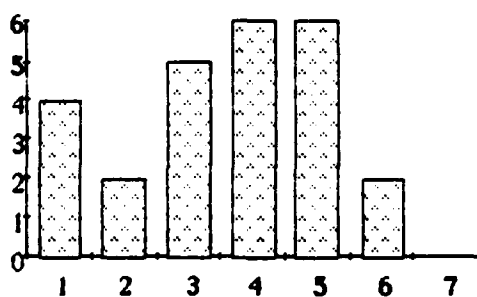
**AGS MSs:Q7**



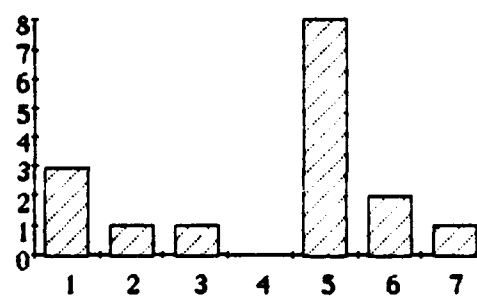
**EMS MSs:Q7**



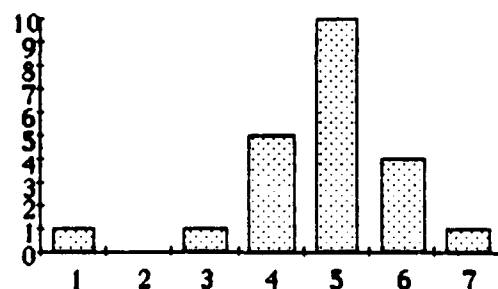
**DCMs:Q8**



**CRS MSs:Q8**



**AGS MSs:Q8**



**EMS MSs:Q8**

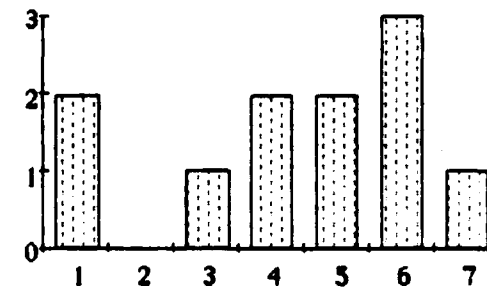


Figure D.29. Survey Response Histograms [Section 3]

[Questions 9 & 10 on this page use a scale of  
1 (very little extent) to 7 (very great extent)]

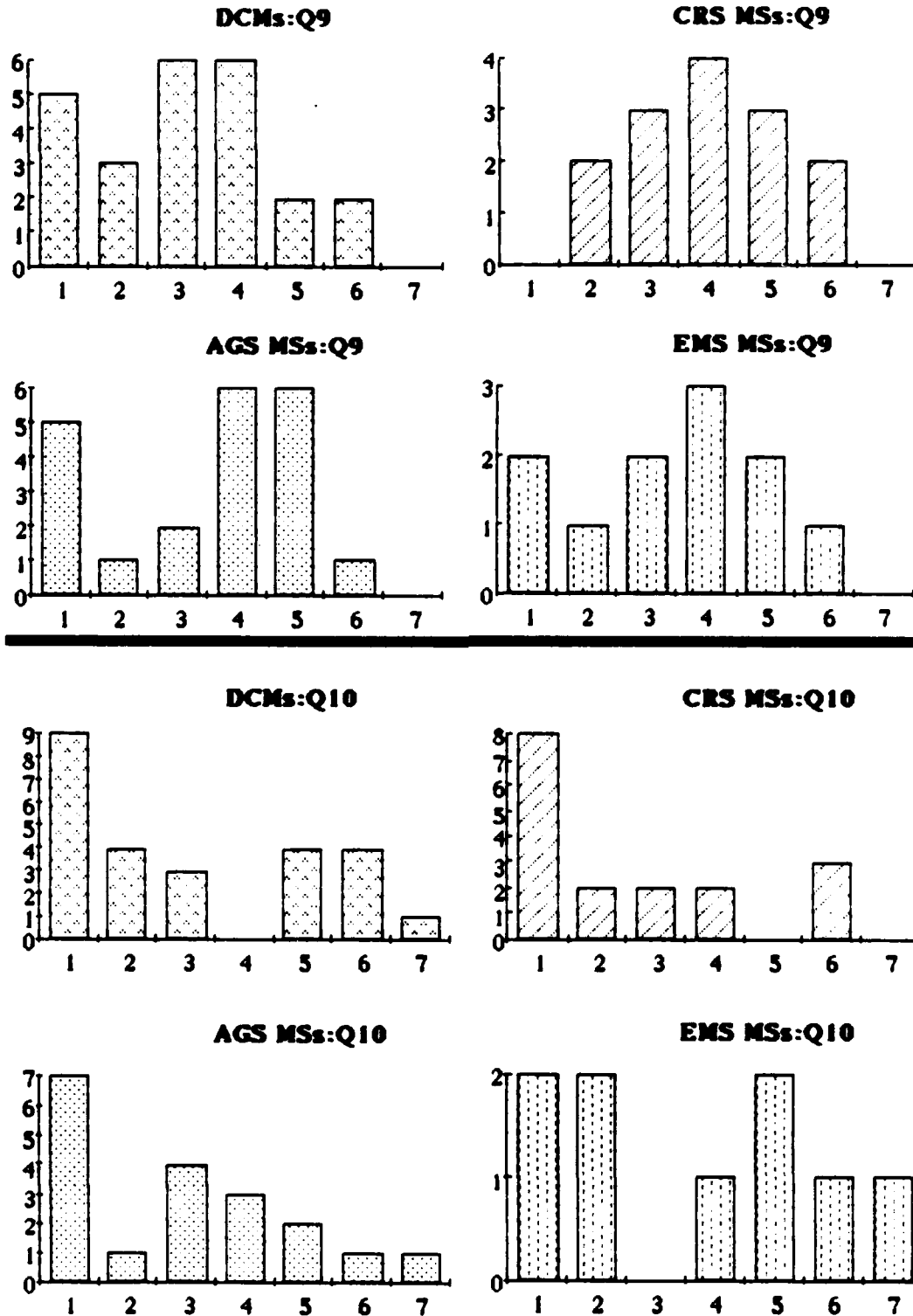


Figure D.30. Survey Response Histograms [Section 3]

[Questions 11 & 12 on this page use a scale of 1 (very little extent) to 7 (very great extent)]

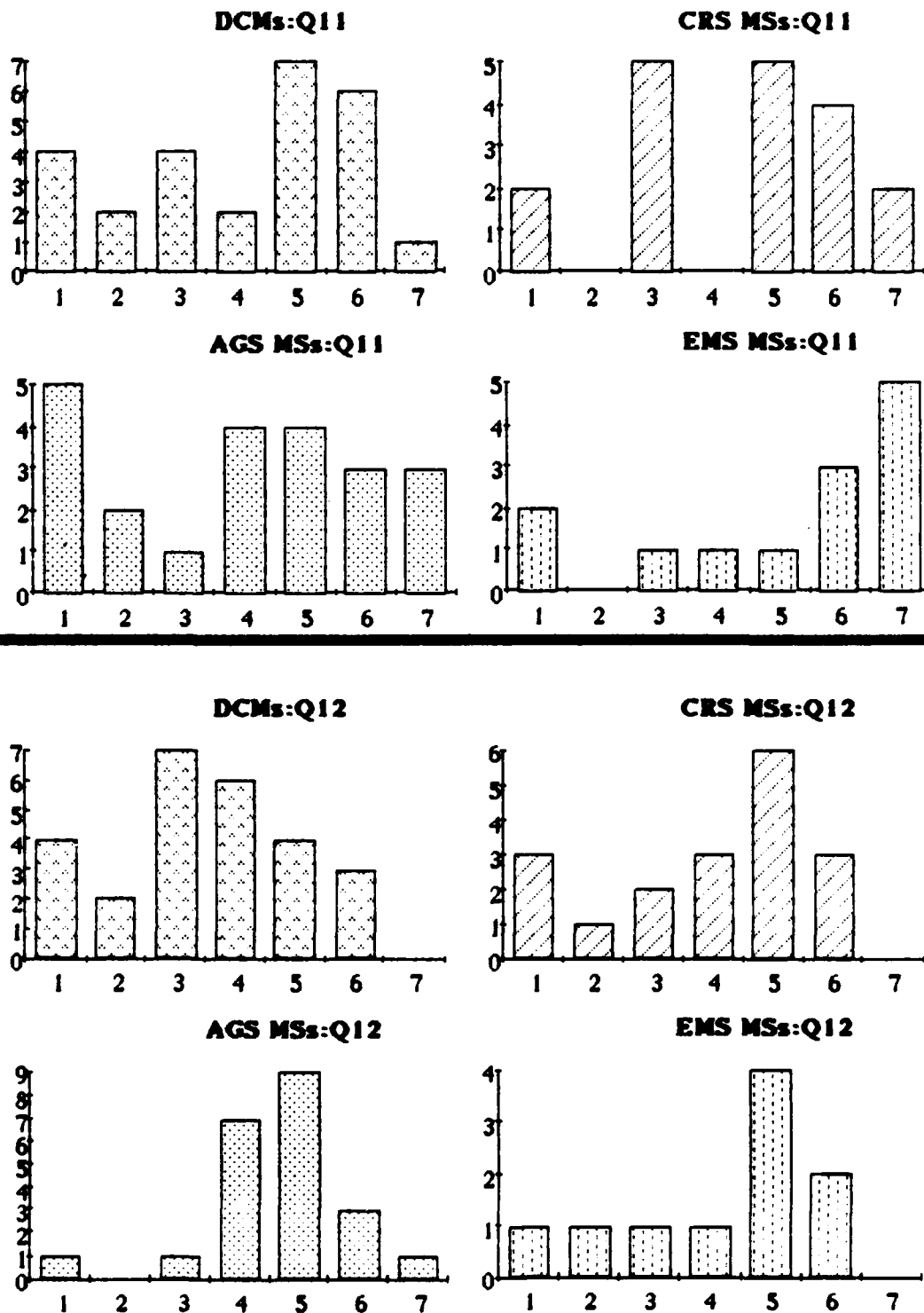
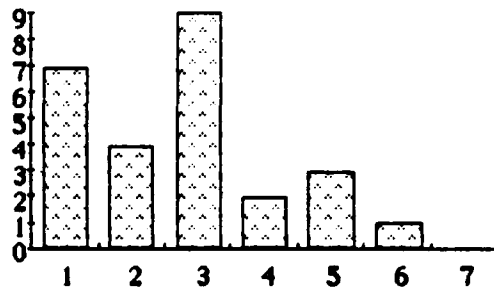


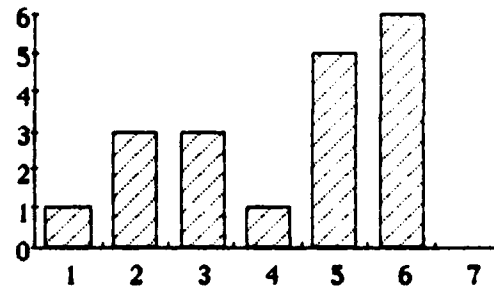
Figure D.31. Survey Response Histograms [Section 3]

[Questions 13 & 14 on this page use a scale of 1 (very little extent) to 7 (very great extent)]

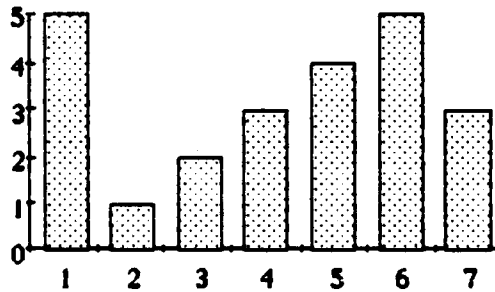
DCMs:Q13



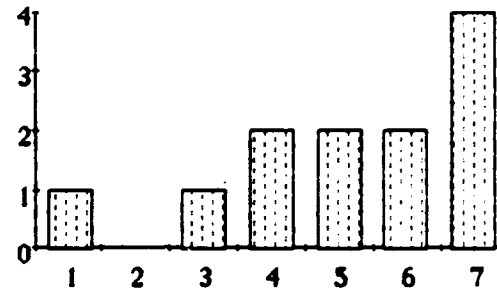
CRS MSs:Q13



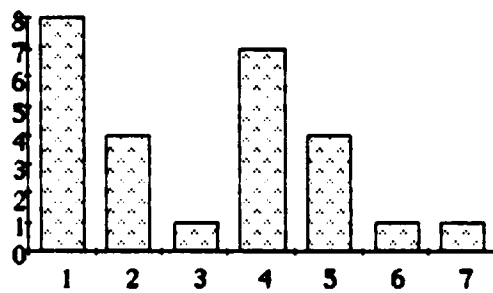
AGS MSs:Q13



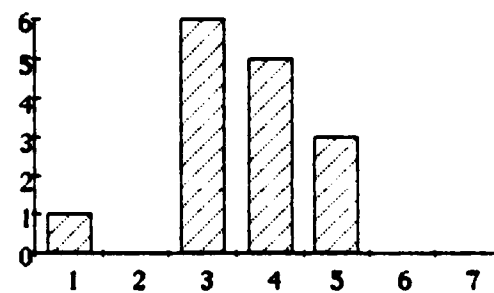
EMS MSs:Q13



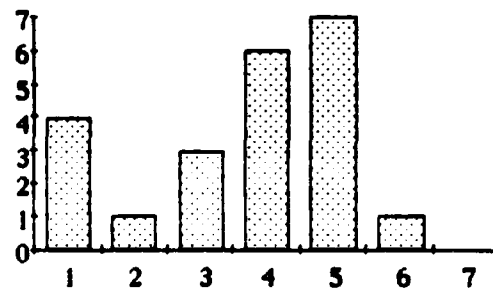
DCMs:Q14



CRS MSs:Q14



AGS MSs:Q14



EMS MSs:Q14

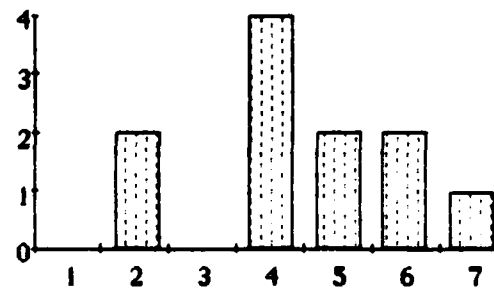


Figure D.32. Survey Response Histograms [Section 3]

[Questions 15 & 16 on this page use a scale of  
1 (strongly disagree) to 7 (strongly agree)]

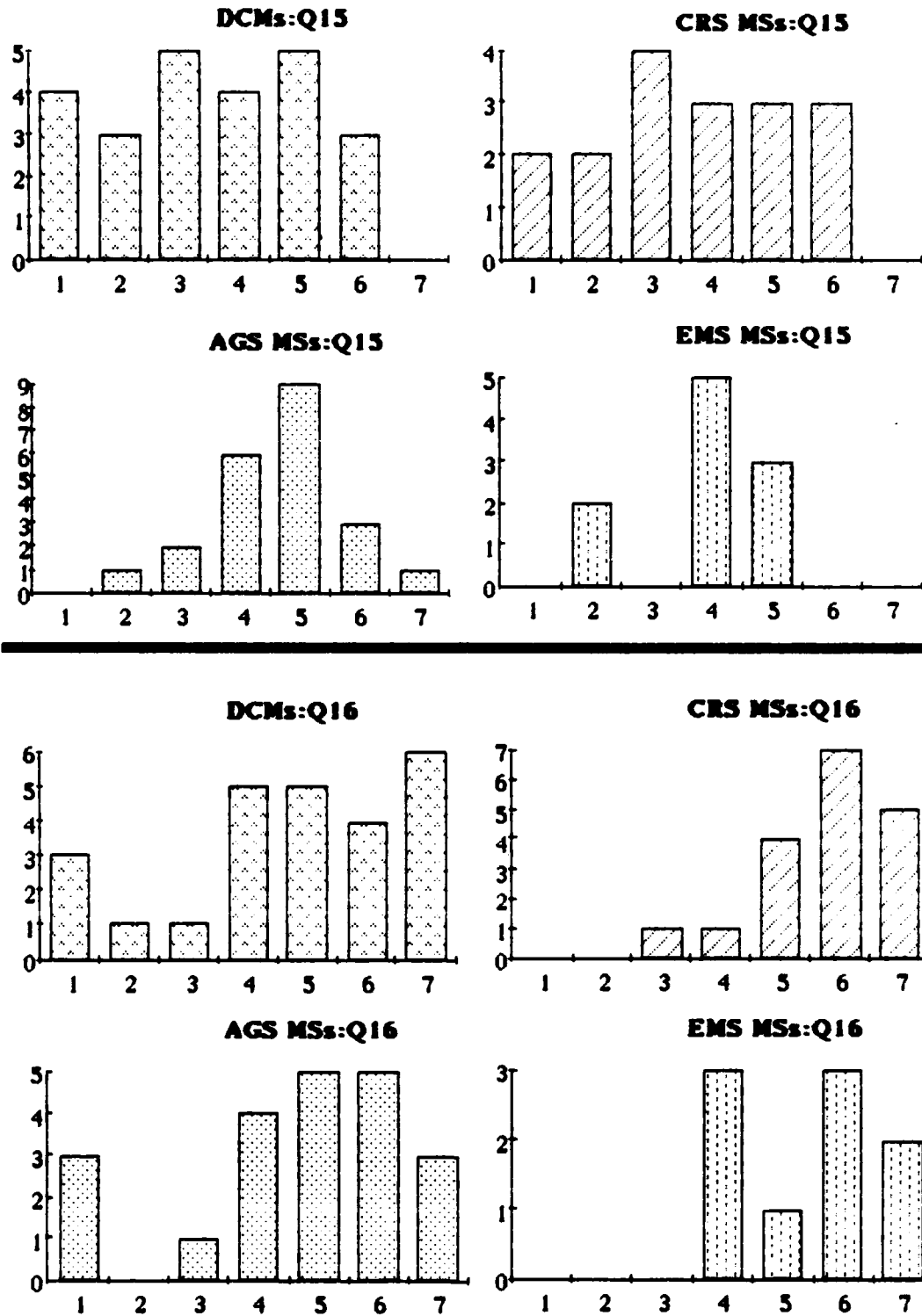


Figure D.33. Survey Response Histograms [Section 3]

[Questions 17 & 18 on this page use a scale of  
1 (strongly disagree) to 7 (strongly agree)]

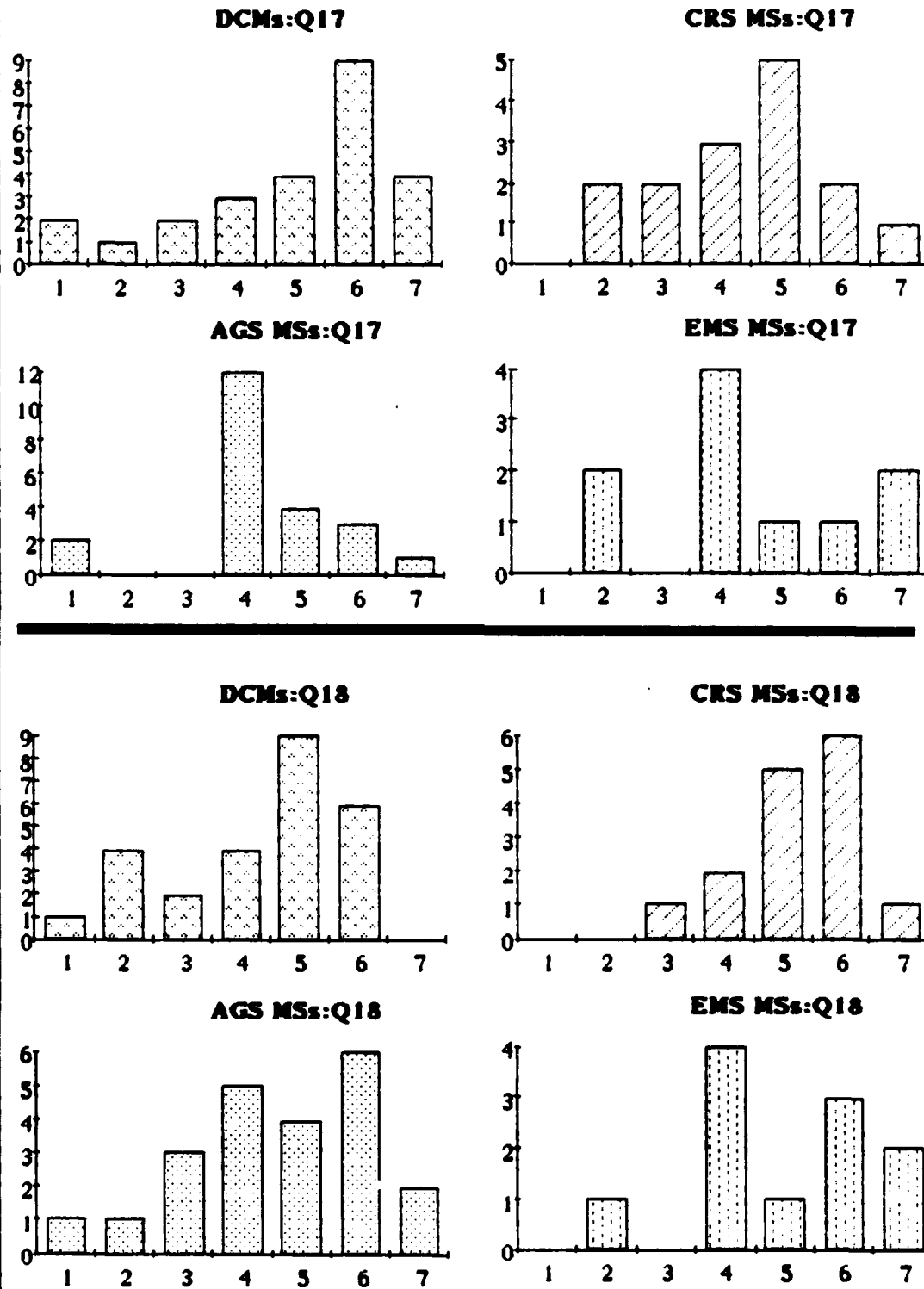


Figure D.34. Survey Response Histograms [Section 3]

[Questions 19 & 20 on this page use a scale of  
1 (strongly disagree) to 7 (strongly agree)]

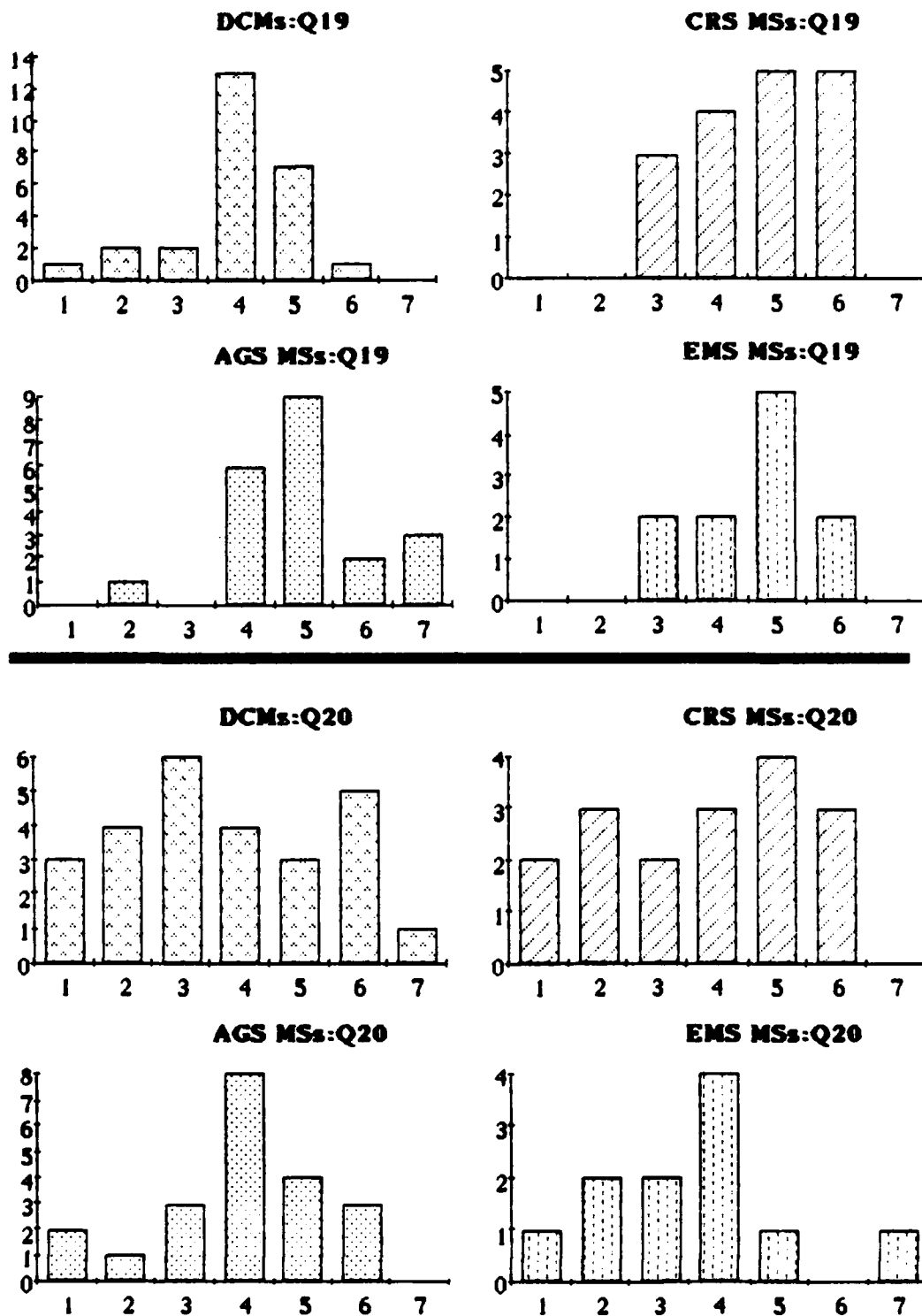
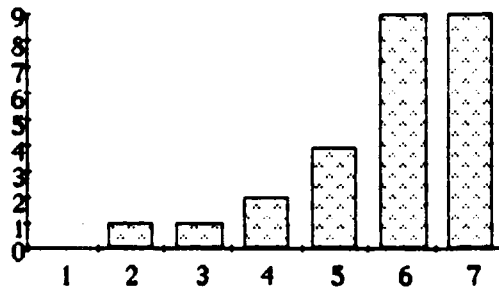


Figure D.35. Survey Response Histograms [Section 3]

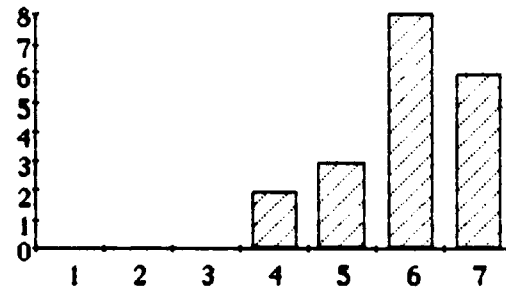


[Question 21 on this page uses a scale of  
1 (strongly disagree) to 7 (strongly agree) &  
Question 22 uses a scale of 1 (all of the time) to 7 (never)]

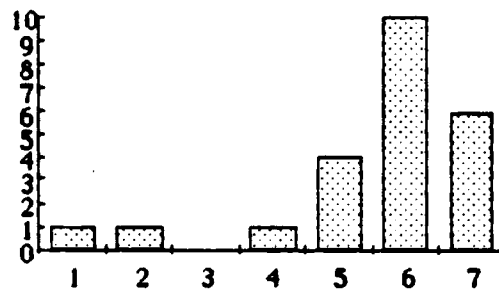
**DCMs:Q21**



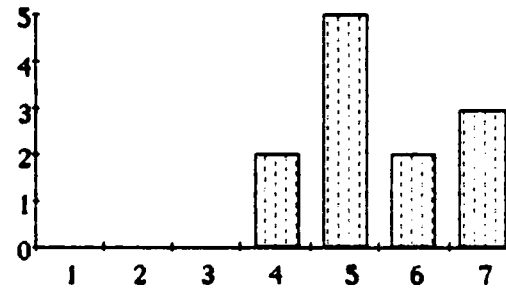
**CRS MSs:Q21**



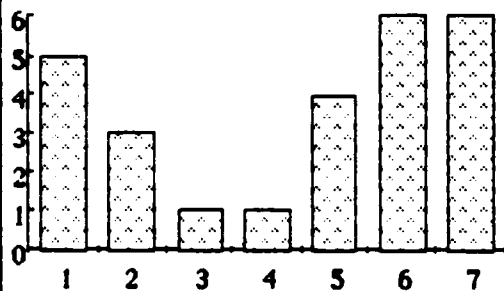
**AGS MSs:Q21**



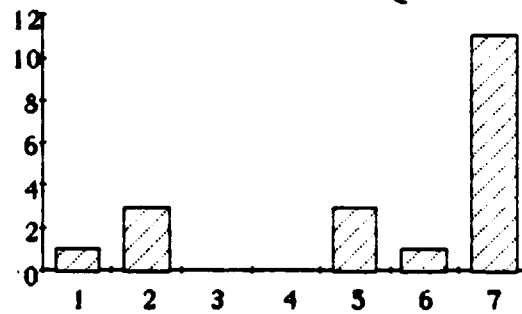
**EMS MSs:Q21**



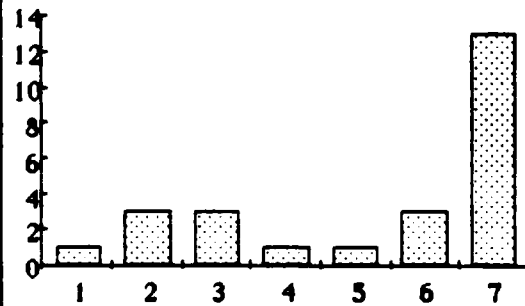
**DCMs:Q22**



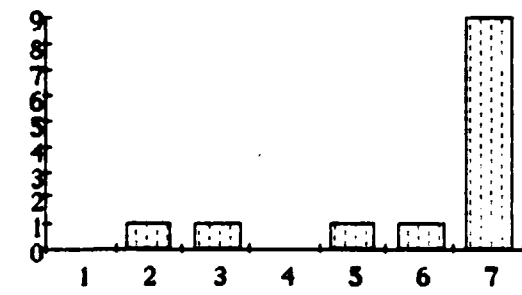
**CRS MSs:Q22**



**AGS MSs:Q22**



**EMS MSs:Q22**



**Figure D.36. Survey Response Histograms [Section 3]**

[Questions 23 & 24 on this page use a scale of  
1 (all of the time) to 7 (never)]

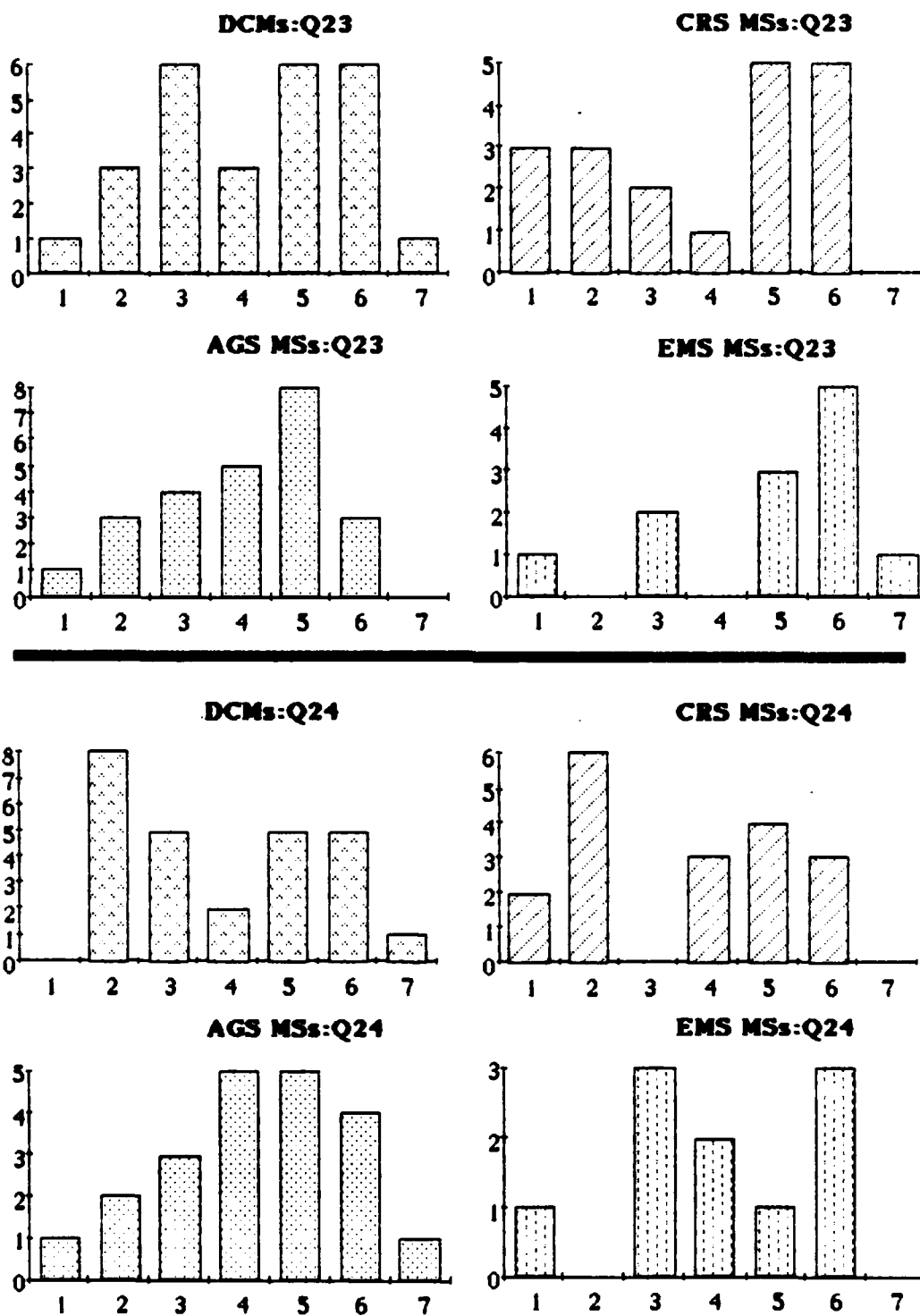
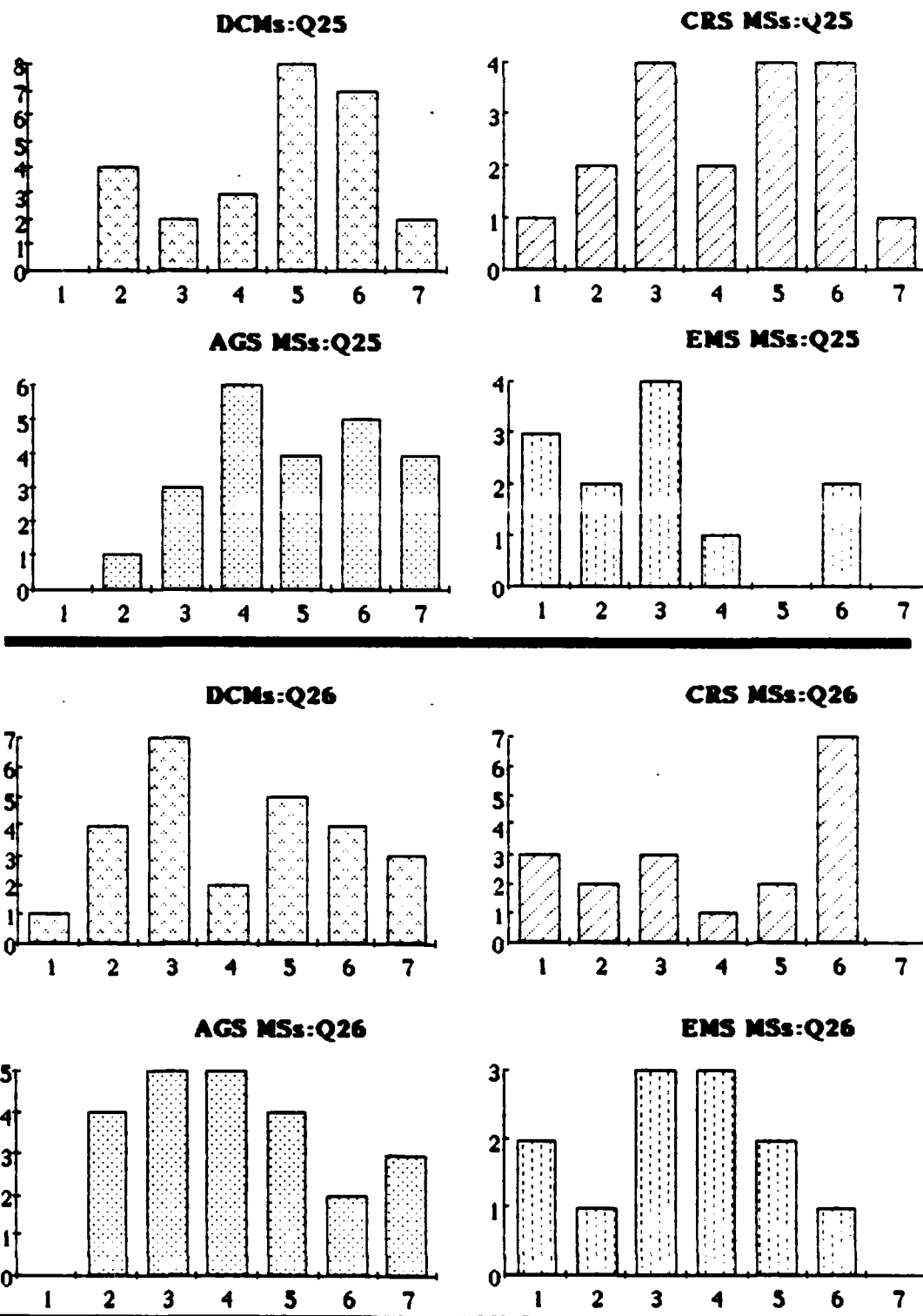


Figure D.37. Survey Response Histograms [Section 3]

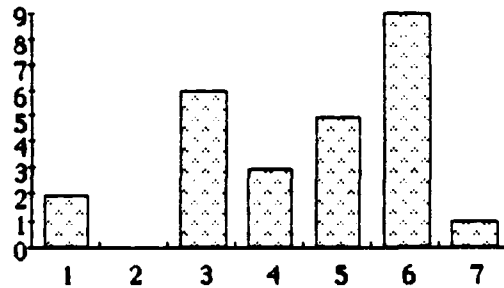
**[Questions 25 & 26 on this page use a scale of  
1 (all of the time) to 7 (never)]**



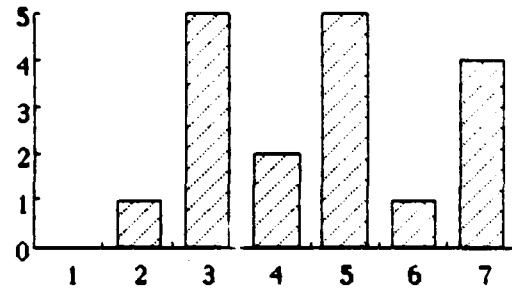
**Figure D.38. Survey Response Histograms [Section 3]**

[Questions 27 & 28 on this page use scales of  
1 (all of the time) to 7 (never)]

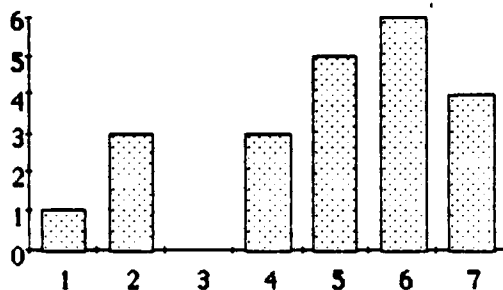
**DCMs:Q27**



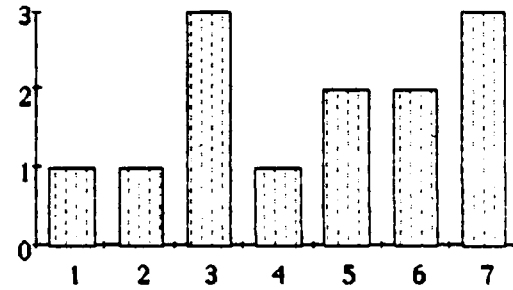
**CRS MSs:Q27**



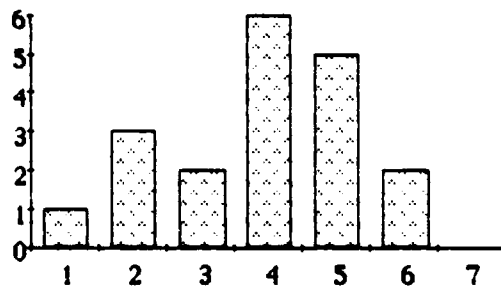
**AGS MSs:Q27**



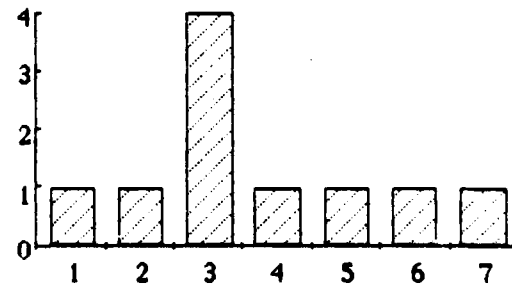
**EMS MSs:Q27**



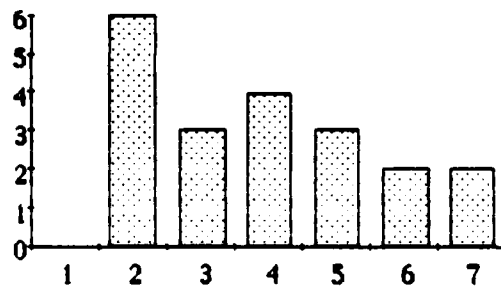
**DCMs:Q28**



**CRS MSs:Q28**



**AGS MSs:Q28**



**EMS MSs:Q28**

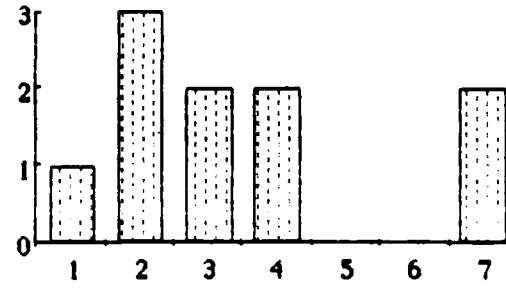


Figure D.39. Survey Response Histograms [Section 3]

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## VITA

Captain James T. Silva [REDACTED]  
[REDACTED]  
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[REDACTED] He then attended the United States Air Force Academy, Colorado from which he received a Bachelor of Science degree of in Aeronautical Engineering in May 1980. Upon graduation, he received a regular commission in the USAF. His first assignment was to Chanute AFB, Illinois for Aircraft Maintenance Officer Technical Training. Following that graduation, he was assigned to the 366th Tactical Fighter Wing at Mountain Home AFB, Idaho, where he worked on the F-111A and EF-111A weapon systems. In 1984, Captain Silva was then selected to work as a Maintenance Supervisor in the 4450th Tactical Group assigned to Nellis AFB, Nevada. During his tour there, he completed Squadron Officer School by correspondence and in residence. In 1987, Captain Silva left the Tactical Air Command to attend the School of Systems and Logistics at the Air Force Institute of Technology at Wright-Patterson AFB, Ohio. Upon completion of the Master of Science program in Logistics Management, Captain Silva was selected to work at the Air Force Logistics Management Center in Gunter AFS, Alabama.

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The R & M 2000 program provides a new outlook on the reliability and maintainability of all weapon systems. This thesis was based on the premise that to fully institutionalize the R & M 2000 program, a change in the mindset of maintenance managers needs to occur. A behaviorally oriented second order organizational change model described the stages of change managers progress through before any program becomes institutionalized.

Since its inception in 1985, no studies have been conducted addressing the level of institutionalization of the R & M 2000 program in the Tactical Air Command (TAC). In this study, 145 TAC Deputy Commanders for Maintenance and Squadron Maintenance Supervisors were surveyed to ascertain the extent of their institutionalization of the R & M 2000 program. To determine the level of institutionalization, questions were developed to measure the degree of program implementation, the managers' level of R & M education and training, and the level of use of specific R & M management tools.

Detailed analyses of the survey responses suggested that the implementation of the program was relatively low. The level of R & M education and training in TAC was also deemed as low. In evaluating the management tools, the survey showed opposing results indicating high use. However, the managers were not commonly aware that the management tools they used were actually the R & M 2000 tools. Statistical tests revealed that the survey response distributions could not be considered different, allowing conclusions to apply across the spectrum of the maintenance manager population.

Contrary to expectations, this thesis concluded that the R & M 2000 program did not appear to be fully institutionalized in the Tactical Air Command. However, the institutionalization does appear to be beginning at the core process level. Any penetration of the R & M 2000 program to the paradigmatic level may take several more years. (FR)

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